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Human Cestoides.

AN ESSAY

ON THE

TAPEWORMS OF MAN,

GIVING A FULL ACCOUNT OF

THEIR NATURE, ORGANIZATION, AND EMBRYONIC DEVELOPMENT;
THE PATHOLOGICAL SYMPTOMS THEY PRODUCE, AND THE
REMEDIES WHICH HAVE PROVED SUCCESSFUL
IN MODERN PRACTICE.

D. F. WEINLAND, PH. D.

TO WHICH IS ADDED

AN APPENDIX, CONTAINING A CATALOGUE OF ALL SPECIES OF *HELMINTHES* HITHERTO FOUND IN MAN.

ILLUSTRATED WITH ORIGINAL WOOD-CUTS.

CAMBRIDGE:
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1858.

TO

THE MEMORY

OF

JOHANNES MÜLLER,

LATE PROFESSOR OF HUMAN ANATOMY AND PHYSIOLOGY, AND DIRECTOR OF THE ANATOMICAL MUSEUM AT THE UNIVERSITY OF BERLIN;

THE GREAT PHILOSOPHER, WHO FIRST LAID DOWN THE PRINCIPLES OF EXACT PHYSIOLOGY;

THIS TREATISE IS DEDICATED

BY HIS GRATEFUL PUPIL,

THE AUTHOR.

PREFACE.

The present treatise, though mainly intended for the practising physician and student of medicine, may nevertheless be of use and interest to the public in general. There will be found here a condensed account, not only of the most approved methods of proceeding against tapeworms, but also of those startling discoveries which have been recently made in regard to their origin and natural history, which alone can teach us how man can keep free from these parasites, and which therefore should be known and well understood by everybody. I allude here to the genetic connection existing between the human tapeworm and measly pork; and in regard to this topic I would especially recommend the perusal of the second chapter to those who are engaged in preparing pork for the market.

We do not usually look for many scientific novelties in a handbook on a subject which has been so often treated upon as that of the Helminthes of man; but I would call the attention of the professional helminthologist and naturalist to some portions of this work, where, among other new data, he will find descriptions of two interesting new species of human Cestoids, and also a classification of Tænioids, based upon physiological grounds.

In this place I think it proper to inform my readers, that this treatise is the fruit of long-continued investigations, and that I have not only followed for the past ten years the researches of other helminthologists, but also during that time made many origi-

nal observations, dissecting upwards of five thousand vertebrates, mostly for the practical study of the comparative anatomy and physiology of the latter, but always, at the same time, in search of Helminthes. When Curator at the Royal Zoölogical Museum of Berlin (from 1852 until 1855), where fresh animals are almost daily sent for dissection, I gave, besides my embryological studies relating to the development of the Batrachians, particular attention to helminthological observations with the microscope in the laboratory of my revered teacher, Professor Johannes Müller. In December, 1855, I came to this country, accepting the kind invitation of Professor Agassiz, to aid him in his researches into the Fauna of the United States. I have since spent many an hour in the investigation of the American Helminthes, attracted by the interesting inquiry into their identity with or difference from the Helminthes of the same or similar animals in Europe.

I have commenced publishing my observations, so far as they have reference to the Helminthes of man, at the earnest request and advice of my highly esteemed friends, Dr. A. A. Gould of Boston, and Dr. M. Wyman of Cambridge, who assure me that a condensed treatise on the human Helminthes, from the present state of our knowledge, is much wanted by every physician and student of medicine; the only work on the Helminthes of man that has yet been issued in this country being a translation of Brera from the French, originally from the Italian, published in Boston in the year 1817, containing drawings and observations from European specimens only. At first I intended to issue the work on a larger and more expensive scale, but afterwards concluded to condense the most important part, the natural history of tapeworms, into a treatise which would be accessible to all interested in the subject. For the use of the medical profession, in particular, I am about preparing an Atlas, which will contain six plates, large quarto, giving drawings of all the Helminthes of man, and which will form a sequel to the present work. The figures contained in this treatise were drawn from nature

by myself; and in order to secure accuracy, I also transferred them on wood. They have been cut by Mr. L. Prang, of Boston.

It gives me great pleasure to acknowledge thankfully the many services which I have received from friends and colleagues. Professor Agassiz, Professor Jeffries Wyman, Dr. A. A. Gould, and Professor J. B. S. Jackson have most liberally placed at my disposal the specimens of the Zoölogical and Anatomical Museums in Cambridge, and of the Museum of the Medical College, and of the Society for Medical Improvement, in Boston. Moreover, I have enjoyed the free use of the specimens contained in the collection of the Boston Society of Natural History, and, through the kindness of my friends, Dr. H. Wheatland and F. W. Putnam, those of the Essex Institute, in Salem. Professor Joseph Leidy, of Philadelphia, has not only furnished me with some valuable notes respecting the occurrence of human Cestoides in the United States, but also sent me a valuable unique specimen from his collection for further examination. To Dr. B. S. Shaw of Boston I am indebted for the opportunity of dissecting a rare specimen coming from the practice of Dr. Luther Parks. Dr. A. A. Gould has communicated to me drawings relative to Tæniæ of his practice, and to him and also to Messrs. Th. Lyman of Brookline, J. M. Barnard of Boston, E. Habich and Ch. Kessman of Cambridge, J. S. Jenness of Bangor, Me., and L. M. Dornbach of Mechanicsburg, Pa., I would express my earnest thanks for the kindly aid which they have tendered to me in various ways during the publication of this work.

D. F. WEINLAND.

Cambridge, *August* 5, 1858.

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HUMAN CESTOIDES.

INTRODUCTION.

Since the father of medicine, Hippocrates, wrote his work on the diseases of man, more than two thousand years ago, the tapeworm has been regarded in the annals of medicine as a very dangerous evil of the human body. Further, with people generally, there has existed at all times great fear of this parasite; a fear caused not so much, certainly, by the disease, or the inconveniences to which it gives rise, as by the uneasy feeling of having this Helminth* in the intestine, — a Helminth differing in its nature from all other worms, — mysterious in its origin, — wonderful for the length it sometimes reaches; for its faculty of reproducing all its joints over and over again; for its power of throwing off periodically its end joints, which then become capable of free locomotion; and for its tenacity in resisting all kinds of vermifuges usually successful against other parasitic worms.

* "Helminthes," "Entozoa," "Intestinal Worms," are synonymes. The name "Helminthes" is more used by German and French, the name "Entozoa," dating from Rudolphi, by English and American writers.

By elucidating, in the following pages, the truly marvellous nature and development of this worm, we shall show how far the fear of it is well founded, and particularly what the real danger is for those persons afflicted by it; and further, what are the sure signs of its presence, — since very likely many persons may suffer from it without being aware of the cause of their troubles. From the time of Hippocrates an immense number of drugs have been tried and lauded as infallible remedies against this worm, as is generally the case in diseases which are difficult or impossible to overcome; large sums of money have been paid by various governments to such persons as were known to be in the possession of such a secret remedy, in order to secure it at once for the benefit of the public. For some time past medical science has really been in possession of a number of remedies, which seldom fail if skilfully applied. Of these we shall treat in our fourth chapter.

Yet a remedy against a disease is not the only, nor even the first, aim of the true physician. He seeks rather to advise his patients how to avoid the disease, if possible. Before, then, we treat of the remedies which expel this worm, we have to answer the questions, Where does it come from? and, How can we keep free from it?

Until within the beginning of this century it was the general doctrine of naturalists, as well as of physicians, that all intestinal worms originated of themselves, without the egg of another individual, by *spontaneous* (equivocal) *generation* in the juices of the human intestine, or in the flesh. Some physicians considered an excess of vegetable, others, on the con-

trary, of animal food, as effecting such a disposition in these juices as would lead to the formation of Helminthes. C. A. Rudolphi, the father of scientific Helminthology, advocated, as late as 1808, the possibility of a budding out of tapeworms from the villi of the intestine itself.

This theory of a *generatio spontanea*, dating already from Aristotle, and since his time applied to all those lower animals the embryological development of which was hidden or unknown, has turned out to be erroneous, at least in respect to Helminthes, though there are yet some scientific men who adhere to it. Neither a tapeworm nor any other worm, be it organized ever so simply, originates of itself; on the contrary, *every Helminth may be traced back to an egg or germ of another individual.* ("Omne vivum ex ovo." *Harvey.*)

This is one of the results of the earnest labors of some twelve naturalists now living, who have pursued for years the embryological investigation of these curious creatures, and have revealed laws of development of which twenty years ago no man could have had an idea. These laws made the *miraculous* theory of a spontaneous generation unnecessary, by showing the complicated ways and means that nature uses to place these worms in the men and animals in which they are destined to abide.

So we now know, among other facts, that man gets the common human tapeworm (*Tænia solium*) from the hog, by swallowing accidentally a measle, which is the larva of that tapeworm; and we know, moreover, where these measles come from. Of this we shall

treat fully in the second chapter, — On the Embryonic Development of Tapeworms.

Our first chapter must be devoted to a short sketch of the Nature and Organization of Tapeworms generally.

For the use of those who may wish to make Helminthology a special study, we subjoin a list of the most important works on the subject.

The three following *systematic* works are indispensable : —

Rudolphi, C. A. Entozoorum sive Vermium Intestinalium Historia Naturalis. Amstelodami. 1808 – 10. 3 vols. 8vo. Fig.

Diesing, C. M. Systema Helminthum. Vindobonæ. 1850. 2 vols. 8vo.

Dujardin, F. Histoire Naturelle des Helminthes ou Vers Intestinaux. Paris. 1844. 1 vol. 8vo.

On the *Comparative Anatomy and Physiology* of Helminthes we possess, besides Dujardin's just quoted work : —

Siebold, C. Th. von, und Stannius, Herm. Lehrbuch der Vergleichenden Anatomie. Berlin. 1845 – 46. 2 vols. 8vo. Engl. Transl. by W. J. Burnett. Boston. 1854. Art. *Helmintha.*

Blanchard, E. Recherches sur l'Organization des Vers. Paris. 4to.

Owen, R. Lectures on the Comparative Anatomy and Physiology of the Invertebrate Animals. 2d ed. London. 1855. Fig. Art. *Entozoa.*

On *Tapeworms* in particular : —

Eschricht, F. Bothriocephalen, in Nov. Act. Acad. Nat. Cur. Vol. XIX., Suppl. 1841.

Siebold, C. Th. von. Ueber die Band und Blasenwürmer. Leipzig. 1854. 8vo. Fig.

Van Beneden, P. J. Vers Cestoides ou Acotyles. Bruxelles. 1850. 4to.

Huxley, Th. H. Echinococcus Veterinorum. Ann. and Mag. Nat. Hist. 2d ser., Vol. XIV.

Wagener, G. R. Die Entwicklung der Cestoden. Bonn. 1855. 4to. Fig.

Leuckart, R. Blasenbandwürmer und ihre Entwicklung. Giessen. 1856. 4to. Fig.

On *human* Helminthes in particular : —

Bremser, M. Ueber lebende Würmer im lebenden Menschen. Wien. 1819. 4to. Fig.

Küchenmeister, Fr. Die Parasiten des Menschen. Leipzig. 1855. 8vo. Fig. Engl. Transl. by E. Lankester. London. 1857. 2 vols. 8vo.

On Helminthes of the *United States* : —

Leidy, J. A Flora and Fauna within Living Animals. Smithsonian Contributions. 1853. 4to. Fig.

CHAPTER I.

NATURE AND ORGANIZATION OF TAPEWORMS GENERALLY.

§ 1. Tapeworms are in Systematic Zoölogy called *Cestoidea*,* and considered as one of the four Orders of the Class of Helminthes. They are easily distinguished from the remaining three Orders, as soft, flat, tape-like, jointed worms, mostly narrower towards the head and broadening behind.

§ 2. The size of the different species of Cestoides (there are about two hundred described) varies much, the smallest being barely visible to the naked eye, while the largest known species, the *Tænia expansa* of the sheep, reaches sometimes a length of one hundred feet, and another, the *Tænia plicata* of the horse, a breadth of nearly one inch.

§ 3. Mature Cestoides live exclusively in the intestinal canal of vertebrated animals. They occur in all the five Classes of the latter. Different species of Vertebrata have generally different species of these worms; that of the horse differs from that of the ass; that of the sheep from that of the goat; that of the dog from that of the wolf, and both again from that of the fox; and that of the rat from that of the mouse. On the other hand, some Cestoidea are common to different Vertebrata. The *Tænia expansa* is found in a

* From κεστός, *girdle* of Venus. This name dates from C. A. Rudolphi. The Greeks called the tapeworm of man ἕλμινς πλατεῖα, *broad Helminth*.

number of Ruminants, viz. oxen, sheep, chamois, and the European roebuck, but, strangely, not in the deer. It is said, moreover, to live in the *Antilope dorcas* of Northern Africa, and in three different Brazilian species of deer. Two, three, and more, different species of tapeworms have been found in the same species of Vertebrata; sometimes even together in one intestine. In the intestine of a dog about five months old I counted once one hundred and fifty tapeworms belonging to two species (*Tænia cucumerina* and *serrata*).

§ 4. A mature Cestoid may be considered as consisting of three parts, viz. head, neck, and chain of joints.

§ 5. The head may always be easily distinguished, as a smaller or larger knob at the end of the narrow part of the worm.

§ 6. After the head, follows, in most species, a slender neck,

Fig. 1. Common human tapeworm (*Tænia solium*, LINNE). Natural size. Only such parts are represented as are characteristic for the shape of the joints. *H*, head; *a*, 309th joint; *b*, 448th joint; *c*, 569th; *d*, 680th; *e*, 768th; *f*, 849th; *g*, 855th joint, and last but one. This worm measured 3299 millim. (10 feet 9 inches). The specimen, which seems to be entire, is preserved in the collection of the Boston Medical College.

Fig. 2. A mature joint of the same. Natural size. Showing the dendritic *uterus* and the *genital opening*, *o*.

smooth and entire anteriorly, but irregularly wrinkled behind. The wrinkles grow out into regular transverse folds, thus dividing the worm into distinct joints. The young tapeworm, termed *Scolex*, consists only of head and neck, and this neck becomes — in the manner described above — the originator of new joints, never ceasing as long as the head lives, from which the neck itself is constantly growing out. A Cestoid, therefore, has virtually an endless growth. It follows, also, that the joints next to the neck are always the youngest, and those farthest from it the oldest. This scale of age is exhibited very instructively in the degree of development of the sexual organs, of which we find not even indications in the first joints, but which become more and more prominent as we follow the series of joints downwards. Thus, for instance, I have not found ripe eggs before the 365th joint in the *Tænia solium*, figured on page 6.

§ 7. The growth of the Cestoidea seems to be rather rapid. One of the species which live in the dog, the *Tænia marginata*, Batsch, reaches its maturity and a length of about a foot within ten weeks (Leuckart); and *Tænia serrata*, which is found in the same animal, even within thirty-eight days (Siebold).

§ 8. In spite of the constant growth of new joints, the length of the Cestoid has a certain limit, differing, however, to a considerable extent, in different species. The last mature joints free themselves from the rest of the chain. As this detachment is repeated constantly, the worm does not grow over a certain length. These detached joints do not die, but begin a short individual existence for themselves. They

move freely and somewhat quickly, like leeches. Dujardin described them as a distinct genus, under the name of *Proglottis;* but when the true nature of these worms was understood, the name *Proglottis* was applied to that stage of development in all tapeworms; and henceforth we shall call the free and ripe joints of all Cestoidea *Proglottides.*

§ 9. In the intestine of any Vertebrate that has a tapeworm, we generally find also the proglottides of that worm on their way to the anus. Their destiny is to reach the outer world, — either being discharged with the excretions of the animal, or passing out voluntarily, — and then to spread their eggs. I have seen proglottides of *Tænia cucumerina* of the dog crawling round, like leeches or flukeworms, on a moistened plate, for more than half an hour, and constantly pouring out balls of eggs clearly visible to the naked eye.

§ 10. The eggs of a Cestoid never hatch in the same intestine in which that Cestoid itself lives.

§ 11. Some modern physiologists, — Steenstrup, Siebold, Van Beneden, and Leuckart, — starting from the decided individuality of the proglottides, have considered the whole tapeworm, not as one individual animal, but as a group of individuals,* to be compared to the many individual *Medusæ* which are formed out of the body of *Hydra fusca* by transverse division. This is decidedly the only true view. The

* Blumenbach held the similar though wrong idea, that a tapeworm consists of many individual worms, each joint being an individual; the second clinging by suction to the end of the first, the third into that of the second, and so on; and he compared this manner of living to that of certain authors, where one after another lives and thrives at the expense of his predecessor.

articulation of a Cestoid is by no means homologous with that of an earthworm or of a caterpillar, or of any other true Articulate. We might say, there is a polymorphism of individuals in the mature Cestoid; the head is an individual of a peculiar kind, bearing nearly all the psychical * organs of the whole colony, particularly the organs by which the colony is attached to the walls of the intestine. Moreover, this head has the faculty of reproducing by budding another kind of individual, namely, the proglottides, which, instead of psychical organs, are provided with the organs of reproduction. We have a very similar polymorphism among Hydroids, particularly in Hydractinia, where in one and the same colony some individuals only feed; others do nothing but produce eggs, others semen; others again, having a horny skeleton, and projecting above the rest, protect the feeders, the males and the females, in case the shell, to which the whole colony is attached, rolls over.

§ 12. Many tapeworms throw off from time to time long chains of ripe joints, — ten or more proglottides still connected. So it is with *Tænia solium*, and particularly with the *Bothriocephalus latus* of man, while the *Bothriocephalus punctatus*, which lives in the sculpin of the Baltic (*Cottus scorpius*) throws off its whole chain of joints every year, and then sends out a new one from the neck (Eschricht).

§ 13. This peculiarity of Cestoids often causes great difficulty in expelling the human tapeworm. It very often happens, that, after the application of a remedy, the whole chain of joints, or nearly the whole, is discharged, yet the remaining head and neck, less

* See below, under § 16.

affected perhaps by the remedy because buried in the mucous membrane of the intestine, will soon reproduce the whole tapeworm.

§ 14. In the annals of human pathology we find many cases recorded where, in all probability, a single head of *Tænia* or *Bothriocephalus* lived a number of years, constantly producing new joints.

§ 15. The *Organization of a mature Cestoid* has been found to be more complicated than might have been suspected in so "low" an animal, and even now-a-days we cannot say that its anatomical structure is fully understood.

§ 16. We call those organs of an animal which stand in immediate relation to its life in the outer world, *psychical* organs.* Here belong the senses, the central nervous system, and the organs of locomotion.

§ 17. We cannot expect a high "psychical" organization in an animal that lives in the intestine of another, and which, attached there, waits quietly to be fed by the passing juices of its bearer.

§ 18. The *skin* of a Cestoid — the only perceptive organ it has — is indeed very sensitive, though nervous threads have not yet been traced as reaching into it. It is soft, rather tough, consisting of a thin epidermis and a thick fibrous underlayer (*corium*). It is always moist and exceedingly absorbent.

§ 19. A *central nervous system* has been described by

* We consider the "consciousness of an outer world" as the fundamental principle of the "Psyche" of animals, and therefore call the organs of that consciousness "psychical" organs. They are the senses, or "receptive" organs; the central nervous system, or the "reflective" organ; the organs of motion, or "reactive" organs. For further particulars, see a paper by the author, entitled "A Method of Comparative Psychology of Animals," in the Proceedings of the American Association for the Advancement of Science, at the Baltimore Meeting, April, 1858.

Johannes Müller* thus far only in the genus *Tetrarhynchus*, where it consists of a small ganglion in the midst of the head, from which branches rise to the four muzzles.

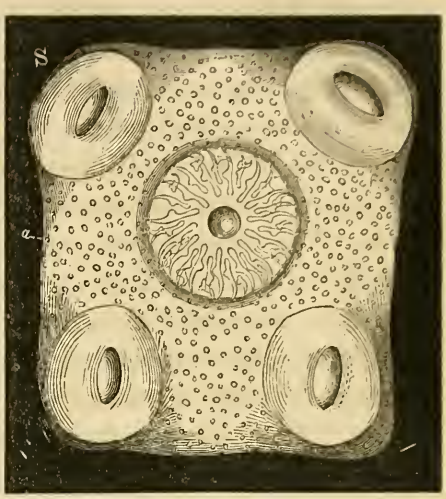

Fig. 3.

§ 20. The organs by which these worms attach themselves to the walls of the intestine are situated on the head. (Fig. 3.) There are four *suckers* in the family of Tænioids, and two in the Bothriocephaloids, consisting of strong muscles, and working, at least in Tænioids, in the manner of cupping-glasses. Moreover, these worms are generally provided with *hooklets* (Fig. 4), either crowning, as in *Tænia*, a central hemisphere on the top of the head (called *proboscis* or

Fig. 4.

* See his "Archiv für Anatomie und Physiologie," Jahrgang 1836.

Fig. 3. Head of *Cysticercus acanthotrias*, Weinland. About 50 times magnified. Seen from above, so as to show the four suckers, *S*, at the corners, and the crown of hooklets in the middle. *a*, *lime globules*, lying between the muscles and in the skin, being a rudimentary skeleton. This *Cysticercus* is the larva of a Tænioid, as yet undescribed.

Fig. 4. Hooklets of *Cysticercus acanthotrias*, Weinland. Magnified 350 times. They are in this species arranged in three rows; those of the innermost row (1) being the largest, those of the outermost (3) the smallest.

rostellum), or, as in *Tetrarhynchus*, arranged on four long and slender proboscides, the latter being homologous with the four suckers of the Tænioids. These proboscides can be inverted into a bag, like the finger of a glove. The process of this inversion, which occurs also in other Helminthes, viz. in the order of *Acanthocephala*, is not, as it seems generally understood by helminthologists, a simple and immediate muscular retraction, but, as I have seen clearly in *Tetrarhynchus* and *Echinorhynchus*, is performed by the formation of a vacuum in the bag, into which the proboscis is then forced by the external pressure of the air. This vacuum is produced by the muscles which are attached to the outside of the bag, and which when contracting enlarge the volume of the bag. Thus, if no muscle works, the proboscis is stretched out, and this, of course, is always the case while the worm is attached to the walls of the intestine.

§ 21. *Motion* in full-grown tapeworms is very limited. Yet a distinct layer of muscular fibres under the skin has been recognized, which very likely aids in the extensive longitudinal contractions of these Helminthes when living, particularly of the proglottides. But we would here remark, that we have not to look in these lower animals for muscular fibres wherever there is a voluntary contraction, nor for nerves wherever we notice a sensitive perception; for it is evident that the general tissue of these worms, and also of Infusoria, Polypi, and Hydroids, often performs such functions as are in higher animals always confined to organs of a certain structure.

§ 22. Microscopic roundish or oval globules, shining like glass, and by their structure reminding us of amylum globules (grains of starch), but consist-

ing really of carbonate of lime, occur in all tapeworms.* They are mostly attached to the inside of the skin, throughout the worm, and have often been mistaken for eggs by the inexperienced observer. Siebold first considered them (and rightly, we think) as a sort of skin skeleton, such as we find in many of the lower animals.

§ 23. In contradistinction to the psychical or external organs mentioned above (§ 16), we shall call all those organs *somatic*, that is, "bodily," which are subservient merely to the support of internal, bodily life.

§ 24. The somatic organs of tapeworms are hardly more developed than the psychical ones. There is no mouth nor intestine, for neither the four suckers nor the proboscis are perforated at the bottom so as to lead inwards, though this has been stated by some observers. The question how these worms feed, is yet an open one; they are supposed to do so by imbibition through the skin. The fact, however, that this feeding by imbibition was generally believed to exist in another order of Helminthes, the *Echinorhynchi*, which, as was discovered two years ago, in three species, really have two external openings, conducting the food into their nutritive system,† leads us to suppose that there may also exist in tapeworms such openings, leading into the nutritive canals described in the following paragraph. ‡

* See Fig. 3, in § 20.

† See D. F. Weinland on the Digestive Apparatus of *Acanthocephala*, in the Proceedings of the American Association for the Advancement of Science, at the Albany Meeting, August, 1856.

‡ Since writing the above paragraph, I find that such openings have recently really been seen in some cases; viz. in *Tænia serrata*, by Leuckart, and in *Tænia osculata* and *Dibothrium clavæceps*, by Wagener. See R. Leuckart, "Blasen-Bandwürmer," p. 61, and G. R. Wagener, "Entwicklung der Cestoden," p. 16.

§ 25. There are easily recognized, in a transverse section through an alcoholic specimen, two pairs of *longitudinal canals*, running along the sides of the worm, and connected in every joint by transverse canals, all four meeting in the head of the worm, in a vascular ring round the proboscis. Their contents consist of a watery fluid. This is no doubt the nutritive system of these Helminthes.

§ 26. The *reproductive organs* of Cestoidea are largely developed. They are really the organs which, in all animals, from man down to the zoöphyte, are in their main features homologous.

§ 27. All tapeworms are *Hermaphrodites.* The sexes are not only united in the whole of the tapeworm, but each joint, for itself, has its own independent male and female sexual organs, testicles and ovaries. Of the different degree of development of these organs in joints at different distances from the head, that is, at different ages, we have already spoken, under § 6.

§ 28. The *testicles*, which generally lie in the middle regions of each joint (for example, in *Bothriocephalus latus* and *Tænia solium*), but occasionally in the foremost joint, or on the sides (as I found it in a tapeworm from the golden-winged woodpecker, *Picus auratus*), seem to consist of the same fine, coiled tubes, which are found, almost without exception, throughout the animal kingdom. The *spermatozoa* are filiform. In the above-mentioned tapeworm of the woodpecker they were of a very strange nature, moving in long, rather slow, snake-like undulations, and not in those quick, tremulous motions that we are wont to see in spermatozoa. Moreover, some

broke in halves, when bursting out from the testicles, and then both halves moved on.*

§ 29. A distinct canal (*vas deferens*) leads the semen from the testicles to the so-called cirrus-bag. (The word *cirrus*, which means a fine hair, is used for the hairlike penis of Helminthes.) To speak more accurately, the semen is led into a vesicle within the cirrus-bag, from which it is ejected through a canal (*ductus ejaculatorius*) into the hollow penis. This latter is generally large and muscular, and is often covered with bristles.

§ 30. The *female organs* are more difficult to study. There are, as in Suckworms (*Trematoda*), two kinds of organs to prepare the eggs; one, called *germ-stock*, which prepares the simple germ-vesicles, and another, called *yolk-stock*, which prepares only yolk.† The canals of both organs meet in the uppermost part of the uterus, where, as Kölliker, Siebold, and others have stated, the germ-vesicles are surrounded by yolk, and then a membrane — the first egg-shell — formed over the yolk, or, as we are inclined to think from observations in other animals, where the germ-vesicle receives the yolk by imbibition, and thus the vesicle itself becomes the egg. The *uterus* is either, as in *Bothriocephalus*, a long, winding tube, and then always easily recognized by the yellowish eggs with which it is filled; or, as in the genuine Tænias, bag-

* See Proceedings of the Boston Society of Natural History, Vol. VI. p. 59.

† These yolk-stocks can be beautifully studied in a tapeworm belonging to the genus *Dibothrium*, which is found frequently in the spiral intestine of *Lamna punctata*, our common mackerel-shark. I saw plainly the ducts which unite the different glandulæ. They are also distinctly seen in a Suckworm (*Trematode*) from the stomach of a common skate of our coast (*Raja ocellata*), where the different stocks are grape-like.

like, with many branches ending in small blind sacs. It contains in mature joints always, and nearly exclusively, ripe eggs, while in younger joints we may find eggs in all stages of development. In Cestoides with the first kind of uterus (*Bothriocephalus*), the *eggs* (Fig. 5. 2) are oval, as in all Suckworms. They have only one hard egg-shell, and are hatched by the dehiscence of a small cover on one end. In the Tænias, on the contrary, we always find the eggs protected by two or more shells, the outermost of which is chitinous,* either thick and composed of many small granules (Fig. 5. 3), or thin and membranous (Fig. 5. 1), and then presenting often the most curious appendages. For example, the eggs of the Tænia from the woodpecker mentioned above have two ball-like appendages.

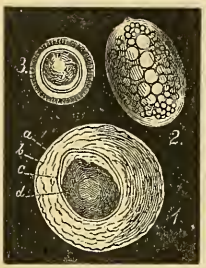

Fig. 5.

§ 31. The number of eggs that one tapeworm produces is incredible. They must be counted by thousands, as will easily appear when we remember that nearly the whole proglottis is filled with minute eggs, and that we often see in one tapeworm a chain of several yards in length, all consisting of ripe joints (proglottides).

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* *Chitin* is the hornlike substance which constitutes the skin, the skeleton, etc. of most Articulata and other lower animals. This chitin has peculiar chemical properties, different from the genuine horny substance found in Vertebrata (in horns, hairs, feathers, scales, epidermis, etc.), which it resembles very much externally.

Fig. 5. Eggs of three different human tapeworms, 350 times magnified. 1. Egg of *Hymenolepis* (*Tænia*) *flavopunctata*, Weinland. 2. Egg of *Bothriocephalus latus*, Bremser. 3. Egg of *Tænia solium*, Linne.

CHAPTER II.

EMBRYOLOGY OF TAPEWORMS.

§ 32. This part of the natural history of tapeworms is the most complicated, but also the most interesting. In speaking of it we shall follow mainly the chronology of the discoveries, in order to afford the reader the pleasure of perceiving how the human mind has penetrated step by step into these mysteries of nature.

§ 33. We have seen above (§ 31) that the last joints of every mature tapeworm, called proglottides, always teem with minute eggs. Now these eggs contain in all tapeworms a globular *embryo*, in which no other organization is visible than three pairs of small spines. (Fig. 6.) In fresh specimens these embryos are generally easily seen, and if the microscopist, by good fortune, succeeds in crushing the egg-shell without hurting the embryo, he may study the motions of the spines, which, working in a horizontal plane from within outwards, are evidently intended to bore a passage through soft animal tissues, by separating the fibres which compose the tissues. Usually the proglottides are discharged with the fæces of the animal in whose intestine the

Fig. 6.

Fig. 6. Embryo of a *Tænia*, from the *Tringa pusilla* of our sea-shore, showing three pairs of spines. 350 times magnified.

tapeworm lives. After a while, these die and decay; but the minute and light eggs will then naturally be washed away by rain, or carried off by the wind, and thus scattered afar. They are likely to come into springs and other water, or into moist ground, etc., and there they will keep fresh, and the embryo which they contain will live for a number of weeks; but exposure to a high and dry temperature, to the sun's heat, etc., would probably soon destroy their life.

§ 34. What became of these eggs and their embryos nobody knew until quite recently. But before we can explain this point intelligibly we must mention other facts, for a long time known, which furnished the clew to the solution of this interesting problem.

§ 35. Every butcher is acquainted with the disease in the muscles of the domesticated hog, called the "measles," and calls the flesh of such a hog "measly pork." It has long been known that those pea-like, whitish globules (measles) contain a curious animal, namely, the perfect head and neck of a tapeworm, ending however, not in the long, jointed body of the regular tapeworm, but in a water-bladder. No traces of reproductive organs are to be seen. Such measles are found not only in the hog, but also in other animals, where they are better known under the name of *Hydatids*. For example, they are

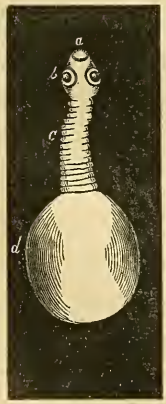

Fig. 7.

Fig. 7. A Hydatid, *Cysticercus*, about five times magnified, showing the head with the circle of hooklets on the top (*a*), and two of the suckers (*b*). The neck (*c*) is wrinkled; it ends in a water-bladder (*d*). — From the liver of a mouse.

very often met with in the liver of rats and mice; in the mesentery of the hare; and even, though more rarely, in the muscles of man; and those of the latter have turned out to be of the same species (*Cysticercus cellulosæ*, Rudolphi) as those found in the hog. All the different species of this sort of hydatids are known in science under the generic name of *Cysticercus*.*

§ 36. Again, other hydatids, varying from the size of a pea to a diameter of several inches, are occasionally found in the lungs, the liver, and other organs of man, but more frequently in the liver and lungs of our domesticated Ruminants, such as oxen, sheep, and goats. These hydatids are roundish bladders of a milky-white color, containing a watery fluid, in which swim many whitish granules; each of these granules is, as a good lens will show, a well-developed head and neck of a Tænia, inverted into a little bag. This kind of hydatid, also, has been considered as a distinct genus of intestinal worms, and called *Echinococcus*.†

§ 37. Again, a disease frequently occurs in the brain of sheep, producing vertigo (German, *Dreher;* French, *tournis*). This was ascertained, years ago, to be caused by another sort of hydatid, appearing as a bladder, often of several inches in diameter; and, as in Cysticercus and Echinococcus, filled with a watery fluid. On the outside of these bladders are

* *Cysticercus* means "bladder-tail," from κύστις, *bladder*, and κέρκος, *tail*.

† *Echinococcus*, from ἔχινος, *hook*, and κόκκος, *berry*, means a berry or ball filled with hooks, viz. the hooklets on the top of the head of the young tapeworms contained in the bladder. Generally we find in such an Echinococcus bladder numerous hooklets, swimming free in the fluid. They are the remains of scolices which have already decayed, probably from age.

attached a number (often hundreds) of tapeworm heads, all retractile into the inside of the bladder by inversion, like the finger of a glove. This hydatid was considered by zoölogists as a third genus, called *Cœnurus.**

§ 38. These three genera, *Cysticercus*, *Echinococcus*, and *Cœnurus*, formed until recently an order in the class of intestinal worms, called *Cystica* (Bladder-worms, or Vesicular Worms). But *we now know that this whole group are merely larvæ of tapeworms*, and that the whole order of *Cystica*, being composed of larvæ of *Cestoidea*, must therefore be dropped from our zoölogical system.

§ 39. This important discovery was made as follows. Ephraim Götze, a German clergyman and naturalist of the last century, had noticed a singular similarity between the heads of some Cysticerci and those of some tapeworms. He had particularly noticed this similarity between the tapeworm of the cat (*Tænia crassicollis*), and the Cysticercus which is found in the liver of the rat and mouse (*Cysticercus fasciolaris*). C. T. von Siebold, the most noted helminthologist now living, had observed the same thing, and in 1848 had already alluded to the possibility that all these Cystica might be nothing but undeveloped or larval tapeworms.† In his system, however, he still recognized the *Cystica* as a distinct order of Helminthes.

§ 40. In the year 1851, F. Küchenmeister first proved by experiment that a certain hydatid, when

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* *Cœnurus*, from κοινός, *common*, and οὐρά, *tail*, because many of the young Cestoids (scolices) end in one common bladder, as it were in one common tail.

† See his "Vergleichende Anatomie," p. 111.

brought into a suitable place, is developed into a tapeworm. He fed a dog with the hydatids (*Cysticercus pisiformis*) found in the mesentery of the hare, and on dissecting the dog, after a number of weeks, *found these Cysticerci alive in the small intestine. They had, however, lost their tail-bladder, and the neck had begun to form the joints of a true tapeworm*, which worm had been long well known as *Tænia serrata*, and as common in the dog. Now, one discovery followed another. Governments, scientific institutions, and wealthy farmers furnished the money and animals to carry on the experiments on a large scale. Siebold* fed a dog with the *Echinococcus* of the ox, and thus raised the *Tænia Echinococcus*, Siebold. It was also found in the same way that the *Cœnurus* from the brain of sheep is the larva of another *Tænia* of the dog, *Tænia Cœnurus*, Siebold.

§ 41. Now the question, Whence does man get his tapeworm? was ready to be answered. It had been observed that the hydatids of the hog, commonly called "measles" (in the zoölogical system, *Cysticercus cellulosæ*), have exactly the same head as the common tapeworm of man (*Tænia solium*, L.); and after the experiments mentioned above, in relation to the different tapeworms of dogs, a doubt could hardly exist *that Cysticercus cellulosæ of the hog was the larva of the common human tapeworm* (*Tænia solium*). Küchenmeister, who wished to make sure of the fact, made the experiment upon a criminal who was soon to be executed, and, as was to be expected, with perfect success. Measles taken from fresh pork, and put into sausages

* "Band und Blasenwürmer," pp. 89 and 95.

which the criminal ate, raw, at certain intervals before his death, were found again, in the post-mortem examination, as tapeworms in his intestine, and in different stages of development, according to the intervals in which the measles had been taken.*

§ 42. Thus it became clear, that all hydatids are tapeworm larvæ, which, when swallowed with the animal, or a portion of it, in which they live, by another animal, develop in the intestine of the latter.

§ 43. Yet, after all these discoveries, the complicated embryonic development of Cestoides was far from being completely known. There was yet in the history of that development a wide gap left, between those ball-like embryos, with their six little spines, and the larvæ, called hydatids. It was in the year 1852, that Stein † made the important discovery which immediately led to the recognition of the true connection between these two stages.

§ 44. He found on the outer walls of the stomach of the mealworm-beetle (*Tenebrio molitor*) small cystes, each enclosing the head of a tapeworm (a *scolex*), invaginated into a bag, very similar to those found in the *Echinococcus* bladder, and by a thorough microscopic examination he found six little spines in the bag, showing by their disorderly positions that they were evidently cast off. These six spines he easily recognized as coming from a tapeworm embryo (§ 35). Stein discovered, moreover, the earlier stages of this worm. He found in some of the cystes the very embryo, evidently just hatched from the egg. Other

* Küchenmeister, "Parasiten," Vol. I. p. 71.

† See "Siebold's und Kölliker's Zeitschrift für wissensch. Zoologie," Vol. IV. p. 205.

cystes he found, in which there had been formed, by interior budding inside the embryo, a simple conglomeration of cells; which in others took the shape of a head; while in others, still more advanced, there were the perfect tapeworm heads (*scolices*) in bags. Thus it was shown that *the scolex is formed by an interior budding in the embryo.* Stein inferred now, and as we think rightly, that the eggs of the tapeworm, when perchance eaten by the beetle, were hatched in its stomach, and, by means of their six little spines, bored through the walls of the stomach, and afterwards developed in themselves the scolex. Their further development into the tapeworm could no longer be doubtful after Küchenmeister's and Siebold's experiments. The hydatid or Cysticercus in the meal-beetle is very likely to be eaten, with the beetle, by an insectivorous bird, or by a bat, mole, or the like, and in the intestine of these animals it would be developed into a perfect tapeworm.

§ 45. Now the opportunity for experiments was again open in another direction. If the embryo developed in itself the scolex, it was likely that those animals that have certain hydatids got them by eating the eggs of the species of tapeworm to which those hydatids belonged. And this has been proved by experiment. Goats fed with eggs of the *Tænia Echinococcus* got the Echinococcus; sheep fed with the eggs of *Tænia Cœnurus* got the Cœnurus in their brain; *healthy young hogs fed with the eggs of the human tapeworm got the measles.* Küchenmeister, Siebold, Van Beneden, Gurlt, Luschka, Wagener, Leuckart, Eschricht, and others, have the merit of tracing this interesting development. From their further investi-

gation, it became moreover evident, that the Cœnurus also, with its many heads, originated from *one* embryo, which, enlarging greatly, throws out as buds from its interior, not one, but many scolices; moreover, that the process is also exactly the same in *Echinococcus*, except that in this hydatid the scolices free themselves after a while from the internal walls of the bladder, and thus swim in the fluid contained in the bladder, the latter itself being simply the enlarged embryo.

§ 46. But the zeal of these investigators did not rest here. If the sheep gets by chance the eggs of the *Tænia Cœnurus* of the dog into its stomach, how do the embryos hatching from those eggs reach a suitable place for their development into hydatids, which place is, in the sheep, the brain? It had been erroneously assumed that they bored with their spines *recta via* from the stomach through all the tissues and organs until they reached the brain. Accordingly, in the hog, the embryos of the Tænia would have to go from the stomach into the muscles; in the rat, into the liver; and in the ox, into the lungs; for it is only in these particular organs that these hydatids are found.

§ 47. R. Leuckart,* however, discovered the way in which the embryos actually reach their destined resting-places. On feeding rabbits with the eggs of *Tænia serrata*, he found that, some hours after the feeding, the egg-shells were already dissolved into prismatic granules by the juices of *the stomach*, and the embryos set free. But on putting the eggs immediately in the *intestine* (through an artificial opening), they were not hatched. It was clear, therefore, that only the

* "Blasenbandwürmer und ihre Entwicklung," p. 110.

gastric juice could hatch the embryos; and this accounts at once for the strange fact mentioned above, (§ 10), that the embryo never hatches in the intestine of the animal where the tapeworm itself lives. Moreover, he found that they do not pass from the stomach into the intestine, and hence, as had been supposed, through the bile-ducts into the liver, but that they pierce the bloodvessels, and *thus come into the circulation.* He even, after a long search, found four perfect embryos in the blood taken from the *vena portæ. It is by the blood that the embryos of tapeworms are carried to the organs in which they develop into hydatids.* It now at once became obvious how easily they reach the muscles, the brain, the lungs, etc. But it is to be supposed that only those which reach the destined organ will develop themselves, while the rest, which are carried to other organs, must perish.

§ 48. To recapitulate: —

1. The eggs of Tænioids are contained in the proglottides, which are detached from time to time from the rest of the worm, and discharged with the evacuations.

2. Thus the eggs are scattered about, and by chance one or many of them (still perhaps contained in the proglottis) are taken up by a suitable animal.

3. In this animal they form hydatids, and in that state they await the chance, again, that the animal which bears them shall be eaten by another.

4. If this second animal is the proper bearer of the tapeworm, the hydatid itself will not be digested in the animal's stomach, but only its water-bladder; while from its neck will now grow out the chain of joints, and it will thus become a regular Cestoid, with organs for reproduction.

§ 49. We have shown in the foregoing pages that the Tænioids never go through the whole process of their development in one animal, but that their larva must reach the intestine of a second, a carnivorous animal, in order to be completely developed into a mature tapeworm.* Now this change of habitat of the larvæ does not take place by their own action, but

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* In other families of the order of Cestoidea we find a mode of embryonic development very similar to that of the family of Tænioids, which has been described in the preceding pages.

The larva of a Bothriocephaloid (*Schistocephalus dimorphus*, CREPLIN), which lives in the abdomen of the European Stickleback (*Gasterosteus aculeatus*), reaches its final development only in the intestine of the duck which has swallowed the stickleback. (Creplin.) I have found a similar larval Cestoid in the abdomen of a small Holocentroid fish (*Rhynchichthys Gronovii*, WEINLAND, Mss.) in Haiti, the full-grown tapeworm of which, unknown as yet, also probably exists in water-birds.

Further, the larvæ of the family of Tetrarhynchoids are found in the mesentery, etc. of codfish, herrings, sculpins, mackerel, and other smaller fishes, while the full-grown Tetrarhynchi live exclusively in the intestine of sharks, which feed upon the former fishes. (Van Beneden.)

Yet not only in the order of *Cestoidea*, but also in that of *Trematoda* (Suckworms), we meet with analogous wanderings of the larvæ. These worms live, when mature, in the intestine, the lungs, the liver, and other organs of Vertebrata; one species, the flukeworm (*Distoma hepaticum*, ABILGAARD), is rather common in the bile-ducts of the sheep. The eggs of these Helminthes reach, in some unknown way, — in the case of the flukeworm of the sheep, probably through the intestine with the evacuations, — the outer world. Most of the eggs perish, but some perchance come into water. From these are hatched minute embryos, provided with vibratory cilia all over the body, by means of which they swim freely, and rather quickly, in the water. They seek to get into, or are swallowed accidentally by water-snails, such as the common Physæ or Limnæi of our ponds. In the liver of these Mollusks they are transformed into a sort of hydatid quite analogous to the *Echinococcus* of Tænioids, — a worm-like sac, which, strange to say, is in most species endowed with an individual organization (mouth and intestinal canal) and locomotion. In these worm-like hydatids, which can be easily recognized by the naked eye on dissecting the snail, there are formed by interior budding another sort of worms, called *Cercariens;* lively creatures, resembling somewhat tadpoles in shape and

they are passively transferred from one animal into the other. They are, as we have shown, swallowed with their first bearer by the second; for instance, the *Cysticercus fasciolaris*, living in the liver of the mouse, is swallowed with the mouse by the cat. Thus the existence of every species of these Helminthes is based upon the natural relation between two different ani-

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locomotion, but which are really minute young Suckworms, provided, however, with a rudder-tail for the purpose of swimming, an appendage which is never found in the adult Trematode. Their internal organization consists in a forked digestive canal with a mouth, and in a vascular system; no signs of reproductory organs are to be seen. Thus these Cercariens are in every respect analogous to the Cysticerci and the Scolices generally in Tapeworms. When advanced to the state of organization described above, the Cercariens leave the worm-like hydatid in which they have originated, and which lies in the liver of the water-snail, and obtain passage outwards, probably through the intestines of the snail. They are found then by thousands, swarming freely in the water where those snails live. But soon they enter a new animal. By means of minute spines, located on their head, they penetrate into a water insect, a Crustacean, or a Mollusk; and while entering they cast off their tail. But even in this second bearer they do not reach their final development. Settling in the tissue of a muscle or other organ of the animal, they form a transparent cyst round themselves, and in this chrysalis state undergo a further development of their internal organs. They now wait the moment when the animal in which they are lodged shall be swallowed by some bird or reptile, or perhaps by some one of the Mammalia. Upon reaching the intestine of this third animal they develop themselves into mature Suckworms, produce eggs, and the complicated circle of development begins anew. (Siebold, Steenstrup, De Filippi, La Valette.)

The manner of development, as described for the orders of Cestoides and of Trematodes, has been called *Alternation of Generation*. (This term has been introduced into science by the ingenious Scandinavian, J. Steenstrup, in his important work, "Ueber den Generations-Wechsel oder die Fortpflanzung und Entwicklung durch abwechselnde Generationen." Uebersetzt von Lorenzen, Kopenhagen, 1842, 8vo. English translation by G. Busk (Ray Society), London, 1845, 8vo. The term signifies, that, from the fructified eggs of a mother-individual of a certain species of animals, embryos are hatched which are entirely different from their mother, but which produce, without sexual organs, by interior budding, one or

mals. For example, that of the following species, *Tænia crassicollis*, *T. serrata*, *T. Echinococcus*, *T. Cœnurus*, *T. solium*, depends respectively upon the relation existing between the mouse and the cat, the rabbit and the dog, the ox and the dog, the sheep and the dog, the hog and man; the first of each of these animals being the natural food of the second. Under

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more so-called daughter-individuals, resembling the mother-individual that has deposited the eggs. In some cases, as in the plant-lice (*Aphis*), there intervene even more than one of those agamous generations between the "mother" and the "daughter." The difference of this alternation of generation from a development by simple metamorphosis, as observed in nearly all animals, and particularly among insects, is evident.)

There is yet a third order of the class of Helminthes, in which the embryology is analogous, that of *Chordacea*, or *Hairworms*, comprehending two families, — the common horsehair-worms (*Gordiacea*), and the *Mermidacea*, tender, white worms, which the ploughman often finds in rich soil, generally many individuals entangled with each other. From the millions of eggs of the female *Gordius* which are deposited in the water, embryos are hatched in no way resembling their parents. They have a short, limber, sac-like body, and a distinct head with a crown of hooklets. As G. Meissner first observed, this larva penetrates into water insects, particularly the larvæ of flies, boring by means of its spines through the joints of the leg of the insect, and then pushing upwards between the muscles of the leg, until it reaches the abdominal cavity. Here it forms a cyst, and the internal development of the worm goes on to a certain extent. Thus far it has been observed by Meissner. It is most probable that in this state the larva waits until the insect is perchance eaten by another, an insectivorous insect, — a Carabus, for instance. We know thus much, — that in these beetles the young, hair-like Gordius is found, lacking, however, the reproductory organs, and that this Gordius leaves the beetle after a while. When this young hairworm reaches a ditch of rain-water, a spring, or the like, then — and only then — can its final development go on. An individual of the other sex must come into the same water, when they will copulate, and the female will deposit the eggs, etc. A similar development has been observed by Meissner in the family of *Mermidacea*, the embryo being, however, more longitudinal, and thus resembling the adult more than in Gordius. Dr. A. Sager tells me that he has observed the embryology of another kind of Mermis of this country (Meissner, in Germany, saw only *Mermis albicans* and *nigrescens*), which differs in some respects from that

these circumstances the development, and therefore the existence, of these Cestoides, are evidently fortuitous. Thousands of the measles of the hog happily never reach the human intestine, and thus never grow into mature Tænias. Yet Nature has provided well for the maintenance of the species of these Helminthes, by the immense number of eggs and larvæ.

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of the species observed by Meissner. I hope that my learned friend will soon publish his observations in full. For those who would like to follow the embryology of *Mermis albicans*, I would add, that these worms seem to be also rather common in this country. Leidy found them in Pennsylvania, and I have before me a number of specimens furnished by my friend, Mr. Theodore Lyman, of Brookline, Massachusetts.

So much in regard to the embryology of these three orders of Helminthes. Of the embryology of the fourth order, that of Hookworms or *Acanthocephala*, to which belongs the large *Echinorhynchus gigas*, so common in the intestine of the hog, we know nothing. The remaining fifth order of the class of Helminthes, that of *Nematoidea* or Spindle-worms, — to which belong the common maw-worm (*Ascaris lumbricoides*), the pin-worm (*Oxyuris vermicularis*), the Guinea-worm (*Filaria medinensis*), and the like, — shows a rather simple embryology, entirely different from that of the first three orders. The embryos of these Nematoids, when hatching from the eggs, resemble the parents in every respect, and, except in some Filarioids, the whole development is achieved within one and the same animal.

Finally, when contemplating the embryology of these different orders of Helminthes in general, there is one truth which must strike the mind; namely, that the development in three of the orders is utterly retrograde in respect to psychical organization. The *larvæ* of those three orders of Helminthes which, when full grown, are poorest provided with psychical organs, namely, the Suckworms, Tapeworms, and Hairworms, rank psychically highest among all Helminthes, the Nematoda not excepted. What a difference between those lively Cercariæ, the Scolices, and the Hairworm larvæ, so well provided with organs of locomotion, some even with rudimentary eyespecks, on the one hand, and the full-grown, sluggish flukeworms, tapeworms, and hairworms, on the other! It is well known that in Cirripeds and Lernæas (Crustaceans), a similar "decrepitude of age" is observed. These facts can teach us one truth, which has been often overlooked in generalizations in geology; namely, that we must not expect that the latest stages of geological development of the different series in the animal kingdom are necessarily the highest in every respect, and particularly so in respect to psychical organization.

According to an estimate, made from the number of human tapeworms in a certain district, and from the number of eggs they produce, it is probable that, from a million of eggs, scarcely one tapeworm reaches its full development. More than half a million of eggs may perish before the embryos are hatched; but, provided every individual worm produces a million of eggs, the existence of the species is preserved, if but one egg out of the million becomes fully developed. The loss of this great amount of germs seems, at first sight, to be extravagant; yet, here as everywhere, Nature conforms to the strictest economy, that is, effects with the smallest possible means the greatest possible results, and apparently exhibits the most profound and accurate calculation of chances, — a profundity and accuracy extremely difficult to comprehend, when the innumerably varying conditions are taken into account. The number of individuals living at a given time may vary, but for any considerable length of time there is no variation; otherwise there would be a disturbance in the numerical relation of animals, and consequently in the order of nature. For if, instead of one, three or four out of the million eggs were to arrive at maturity, the number of Helminthes would be three or four times as many as at present, and, in succeeding generations, hundreds and thousands of times as many.*

* For further particulars, see a paper by the author, entitled, "The Plan adopted by Nature for the Preservation of the various Species of Helminthes," in the Proceedings of the Boston Society of Natural History for February, 1858.

CHAPTER III.

ON THE DIFFERENT SPECIES OF HUMAN TAPEWORMS.

§ 50. It has for a long time been known that two different kinds of Cestoidea inhabit the human intestine; namely, the narrow or common tapeworm (*Tænia solium*), with a double crown of hooks on the head and marginal genital openings, which is found particularly in the Teutonic nations (Germans, English, Americans); and the broad tapeworm (*Bothriocephalus latus*), without hooks, but with two grooves along the sides of the head, and with ventral genital openings, which seems to live almost solely in the Swiss and in the Sclavonic nations. Some years ago Dr. Bilharz and Siebold described a third human tapeworm, *Tænia nana*, a small species found in an Egyptian; and recently Dr. Küchenmeister has added a fourth, the *Tænia mediocanellata*, differing mainly from *Tænia solium*, with which it has always been confounded, in wanting the crown of hooks. Moreover, the same author has described pieces of a human Cestoid coming from the Cape of Good Hope, as most likely belonging to a fifth human species.

§ 51. Besides these five Cestoides, which live in their mature state in the human intestine, there are met with occasionally some larvæ of tapeworms (hydatids), occurring particularly in the muscles, but also in other tissues of man, yet never in the intes-

tine. One, the *Cysticercus cellulosæ*, which is sometimes found in the muscles of man, is, as stated above, the larva of *Tænia solium;* another sort of hydatid, the *Cysticercus tenuicollis*, which is rarer in man, is the larva of a tapeworm that lives in its mature state in the intestine of the dog; a third, the *Echinococcus hominis*, found rather frequently in the lungs and other organs of man, is the larva of a tapeworm unknown to this day; a fourth, the *Echinococcus veterinorum*, is very rare in man, and is the larva of a tapeworm of the dog.

§ 52. These are all the Cestoides which have hitherto been described as found in man. To my knowledge, there is no full account of the human Cestoides of the United States. In the investigation of the latter I have met with considerable success, as will be seen in the following pages. We shall now enumerate and briefly describe all human Cestoides known to this day, adding, moreover, two new species, thus far peculiar to this country. Observations as to its occurrence in the United States will be found after the description of each species. We will begin with those Cestoides which inhabit the human intestine in the state of mature tapeworms, and then proceed to those which live as larvæ (hydatids) in various tissues of the human body.

A. — Mature Tapeworms inhabiting the Human Intestine.

I. *Common Tapeworm* (*Tænia solium*, Linne).

§ 53. The Linnæan name (from *tænia*, tape, and *solus*, solitary) conveys a wrong idea; cases are

known of several, and in one instance of as many as forty, specimens being found together in the same intestine. The length of this Helminth, according to Diesing, never exceeds twenty-four feet.* Since this species is the most likely to be met with in those countries where this treatise will be read, I shall here speak of it at length.

The head of this worm is about the size of a pin-head, and is generally dark-colored when fresh. It adheres to the walls of the intestine by means of four suckers, shaped and working like cupping-glasses, and by a muzzle, which is situated in the middle of the suckers on the top of the head, and is capable of retraction by inversion into a bag. (See § 20.) This muzzle, called *Rostellum* or *Proboscis*, is provided with a crown of hooks, consisting of two circular rows of twenty-two to twenty-eight hooklets each. Each of these hooklets is fixed into a bottle-shaped bag (*Hakentasche* in German). A very slender neck, without transverse folds, follows the head; it is about half an inch long when fresh, but in alcoholic specimens it is more or less contracted, as is the case with the rest of the worm. After the neck follows the chain of joints, first characterized by rather superficial transverse folds, which by and by become deeper, thus making distinct joints. In the foremost joints, which are extremely small, the transverse diameter greatly exceeds the longitudinal; but they grow proportionally longer and narrower, so that the last mature joints (proglottides) measure about 0.7 of an inch in length by 0.2 in breadth, while the first joints, immediately following the neck, are less than 0.009 of an inch in length by 0.045 in breadth. Küchenmeister, who has furnished the most accurate description of this parasite, counted 825 joints in a specimen ten feet and two inches in length. In the 280th, he saw the first signs of genital organs, which consisted of a dark longitudinal median line, with short lateral branches. In the 350th, the genital

* "Van Doeveren relates the history of a peasant, who, after taking an emetic, evacuated sixty metres (a metre = 39.3720 inches) of Tænia, and who probably would have voided more if he had not broken the worm from an apprehension that he was discharging all his intestines." — V. L. Brera, "A Treatise on Verminous Diseases," English translation by J. G. Coffin, M. D., (Boston, 1817,) p. 22.

openings are clearly visible. They are placed on the margin of the joints, without order, now on the left side, now on the right. In those joints with distinct genital openings, also, the transverse branches of the median dark line, which is the *uterus*, become darker, containing more and more of the yellowish, globular eggs. These in about the 600th joint are provided with one egg-shell only, but in the fully ripe joints (about the 700th) with two. The lateral branches of the uterus number from nine to twenty on each side of the median stem. Both male and female sexual organs open into one external genital opening, the *Porus genitalis*, the male opening lying in front of the female. The penis is sickle-shaped and yellowish; the seminiferous canal, starting from the penis towards the middle, is best visible about the 300th joint, as is the vagina, running inwards at a sharp angle with that canal. Both are generally dark-colored.

§ 54. The *embryonic development* of this worm is now well understood, as may be seen in the second chapter of this treatise.

The egg* measures 0.036 millim.† in diameter; the embryo, which is globular and provided with six little spines for boring, as in all Tænioids, is fully developed in the egg, while this is yet in the uterus of the proglottis. One proglottis contains thousands of these eggs. An ejected proglottis, or some of the eggs, are swallowed by chance with food or drink by a hog. In the stomach of the hog the egg is hatched. The embryo bores into a bloodvessel, and then by the circulation of the blood is carried over the whole body. Those which get into the capillary vessels of the muscles find a suitable place for development. The embryo enlarges to the size of a pea, and by interior budding forms a head, like that of *Tænia solium*, invaginated into a bag. This is the hydatid commonly called "measles." If the head be evaginated, we see a regular *Cysticercus cellulosæ;* that is, a scolex of *Tænia solium*, ending in a water-bladder. This hydatid, if swallowed by man, drops its water-bladder on arriving in the stomach. The neck, which is to this period merely wrinkled, begins to form regular transverse foldings, which by and by grow out into articulations, and thus is formed the chain of joints of the regular *Tænia solium*.

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* See Fig. 5. 3, page 16.

† Millim. = millimetre; one millim. = 0.03937 inches.

§ 55. This is in short the usual development of this worm. But sometimes the eggs are accidentally swallowed by man, and, finding in the human muscles also a suitable place for development, the embryo there forms the same hydatid (*Cysticercus cellulosæ*). This hydatid, which may reach a length of half an inch, has, moreover, been met with occasionally in other animals, such as oxen, dogs, deer, bears, rats, and monkeys. The tapeworm itself has never yet been found anywhere save in man, though certainly its hydatid is often swallowed by dogs, cats, etc. It seems, therefore, that it can only live in man.

We must mention here, however, the opposite opinion of Siebold, namely, that the *Tænia crassicollis* of the cat, the *T. serrata* of the dog, and the *T. solium* of man, belong to one and the same species; and that the specific characters which distinguish them when fully grown, are only owing to the different circumstances under which they are developed; in other words, that one and the same kind of tapeworm becomes *Tænia crassicollis* in the cat, *T. serrata* in the dog, and *T. solium* in man. We cannot agree in this respect with the distinguished helminthologist of Munich, for not only is the organization of the head in these three Tænias entirely different, but it has been proved by experiments by Leuckart and Küchenmeister, that the hydatids of the hog (*Cysticercus cellulosæ*) do not grow into tapeworms when given to a dog, but die in the stomach and intestines of the dog. The same negative results were obtained by feeding rabbits with the eggs of *Tænia solium*, which, according to Siebold's theory, should have produced *Cysticercus pisiformis* in the mesentery of the rabbit.

§ 56. By the manner of development of *Tænia solium*, L., as given in § 54, we see that *protection* (prophylaxis) from this worm lies theoretically in this simple rule, — avoid all chance of swallowing the fresh measles of the hog. Since the temperature of boiling water kills these larvæ, we can be sure that

in *thoroughly* cooked * pork the measles are destroyed; the same is most likely the case with well salted pork,† which destroys them by acting on the juices of their body. Smoking very likely has the same destructive effect, at least after some time. Now, since man generally eats pork prepared in one of these ways, there must be other opportunities for the Cysticercus to reach the stomach. We shall only give some hints as to how this may happen. We will suppose that a butcher never knowingly furnishes his customers with measly pork; yet a hog may sometimes contain so few of these hydatids that the most conscientious butcher would not by any possibility notice them. Now in such a case might not a hydatid, a thing not larger than a pea, and looking exactly like a small piece of lard, stick to the knife of the butcher, with which he cuts ham, sausages, hogshead-

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* It hardly need be mentioned, that the astonishing tenacity of life of tapeworms, of which some older authors speak, is fabulous. Yet even the meritorious Brera quotes the following observations as arguments of that tenacity, without the slightest doubt. He says: "Coulet asserts that tapeworms can live more than twelve hours in boiling veal-broth, and come out as brisk and active as they went in. Dr. Fax caused a Tænia to simmer over a slow fire, and observed that he died as soon as common salt, muriate of soda, was added." See V. L. Brera, "A Treatise on Verminous Diseases," p. 28.

† The so-called *salt pork* seems to be not always well salted. For in this way only seems to be accountable a fact I have recently learned from good authority in Boston, namely, that *the soldiers of the Allies in the Crimea disliked the salt pork, because, as they said, it produced in them the tapeworm.* If this was really the case, it shows that there had been shipped some measly pork, in which the measles were yet alive.

The pieces of pork, as they are usually put into the barrels, are too large and too closely packed, rendering it impossible for the brine to penetrate them sufficiently. It often happens that, in a piece cut from the centre of one of these, not the slightest flavor of salt can be perceived, and in such parts the measles would not be affected in the least.

cheese, etc., which are eaten soon after in an uncooked state by man, and to which the hydatid may have been transferred. The same thing might happen in using a kitchen knife, with which pork, cheese, butter, bread, etc. are indiscriminately cut.

Beef is very rarely measly, yet it is so sometimes; and therefore, if a Jew or a Mohammedan should suffer from the tapeworm, it by no means proves that he has disobeyed the commandments of Moses. Might not this commandment of Moses, not to eat pork, have been founded on old popular knowledge of the fact that the tapeworm sometimes comes from this food? We ask this, because our own experience has taught us how common people sometimes know a good deal more about nature than scientific men think. Shortly after my arrival in this country, when speaking with an experienced sportsman about the intestines of hares, which I wished for investigation, he remarked, "We never give them to the dogs, because they get worms by eating them." Ten years ago every helmintholo-gist would have laughed at this; but at this day we know that the measles in the mesentery of the hare really become tapeworms when swallowed by the dog, and Dr. Küchenmeister will be not a little astonished to hear that the American hunters knew this fact long ago, though of course they could not account for it.

§ 57. *Protection from the Hydatid of Tænia solium.*— This is perhaps the most important point for the physician; for though the tapeworm in the intestine is certainly troublesome, yet it never seems to be really dangerous, — at any rate, not so much so as its larva. This, as stated above, occasionally finds its way into man, not into his intestine, but into the muscles and

other tissues, and even into the brain, mostly in places where no physician can tell its presence, and where no surgical knife or medicinal remedy can reach. It has produced death in some cases. We have seen that, when man accidentally swallows the eggs of *Tænia solium*, the embryos hatching from these eggs in the stomach come into the circulation, etc., just as in the hog. It is evident that this might happen in drinking water, or in eating fruits which have lain on the ground, or salad made of lettuce, particularly when this latter, as is sometimes the case, is manured with night-soil. We have observed above, that from time to time the proglottides of the worm pass away from the patients, that they are sometimes found in their beds, etc., and that they are teeming with eggs which become spread about. It might easily happen that one, or even many, of these eggs should by accident reach the human stomach. This is the true danger for the person afflicted with the tapeworm, and for those about him. The worm that lives in his intestine cannot do much injury, but from its eggs he and others may become infested with hydatids. Therefore, the evacuations of such persons, which may sometimes be full of eggs, ought to be destroyed; and not for this reason only, but particularly also as hogs by consuming them surely get the measles. Wherever hogs become measly, it is a sure sign that there is some one in the neighborhood who suffers from *Tænia solium*, though he may all the while be ignorant of the fact. — We shall treat of the remedies for *Tænia solium* in our fourth chapter.

§ 58. *Observations on Tænia solium, in the United States.* — Specimens of this worm, which, as in the

greater part of Europe, so also in the United States, or at least in New England and in Pennsylvania, is certainly the most common human Cestoid, are preserved in all the collections named in the Preface, but mostly without a head. In one head which I had an opportunity to investigate thoroughly,* I found the total length of the smaller hooks to be only 0.117 millim., while Küchenmeister gives 0.126 millim. in his Handbook on the Parasites of Man. Yet, in considering their shape, which is precisely the same as in *Tænia solium*, and, moreover, a remark of R. Leuckart, who found the length also 0.11, I feel certain about the identity. I have also before me a drawing of Dr. A. A. Gould's of Boston, made by himself upon a fresh specimen, and representing evidently the head of the same species. He informed me, moreover, that he had seen, during his practice, about four or five heads of this Cestoid. Prof. Joseph Leidy of Philadelphia, Pa., writes me: "The *Tænia solium* is comparatively rare in our vicinity, though in the course of a number of years I have seen numerous specimens from both the white and black, besides the single specimen from an Indian of Lake Superior, obtained by L. Agassiz." † Prof. Leidy sent me also a specimen of *Tænia* from a *negro* woman in Philadelphia, which is evidently of this species.‡

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* This specimen was communicated to me through Dr. B. F. Shaw; it had come from the practice of Dr. Luther Parks of Boston.

† Concerning this specimen we shall speak below, p. 43.

‡ I have seen recently the large collection of human Cestoidea in possession of "the great Fire King," Chabert, in New York city, quite a number of which are perfect specimens. All that I saw, so far as I could judge in looking at them only through the bottles, seemed to belong to this species.

§ 59. It was not without hesitation that I referred to this species a perfect specimen of the tapeworm, coming from a white person, preserved in the collection of the Boston Medical College, and kindly communicated to me by Dr. J. B. S. Jackson, which I have carefully investigated, and the outlines of which I have represented in the accompanying woodcut.

Fig. 8.

This specimen apparently exhibits the head of *Tænia mediocanellata*, as described by Küchenmeister; it has the same large suckers, and no trace of a muzzle on the top of the head; but all the rest of the worm, and especially the uterus (Fig. 8. 2), being precisely as in *Tænia solium*, I cannot help considering the strange organization of its head as a mere anomaly, of which I shall

Fig. 8. 1. Common human tapeworm (*Tænia solium*, LINNE). Natural size. Only such parts are represented as are characteristic for the shape of the joints. *H*, head; *a*, 309th joint; *b*, 448th joint; *c*, 569th; *d*, 680th; *e*, 768th; *f*, 849th; *g*, 855th joint, and last but one. This worm measured 3299 millim. (10 feet 9 inches). The specimen, which seems to be entire, is preserved in the collection of the Boston Medical College.

2. A mature joint of the same. Natural size. Compressed, so as to show the dendritic *uterus*; o, *genital opening*.

speak further under *Tænia mediocanellata*. The genital openings are rather large, and provided with thick lips. The specimen had not been six months in alcohol when the investigation was made; it looked white, and rather fat, but is nowhere broader than a well-nourished *Tænia solium*. The accurate proportions of this worm are as follows.

The head is club-shaped, rounded in front, and gradually sloping towards the neck. Its transverse diameter is $1\frac{1}{4}$ millim.; the suckers are $1\frac{1}{3}$ millim. in diameter, and nearly touch each other; on the boundaries between them there lies a little blackish pigment. The neck is 1 millim. broad and 8 millim. long, irregularly scalloped in its posterior half. The first distinct joint which follows the neck is 1 millim. broad and $\frac{1}{6}$ millim. long. In the first 35 millim. of the worm we counted 71 very broad and short joints, the first $1\frac{1}{2}$ millim. broad and $\frac{1}{6}$ millim. long; the 71st, 2 millim. broad and $\frac{1}{3}$ millim. long. In the next 23 millim. of the worm I counted 26 joints, longer and narrower in proportion, some of them even longer than broad, perhaps unnaturally stretched. At 58 millim. from the head the joints suddenly grow again broader and shorter (2 millim. broad, $\frac{2}{3}$ millim. long), but then lengthen again gradually, and after 76 millim. more (that is, 134 millim. from the head), in the 170th joint, both diameters are equal, viz. $1\frac{3}{4}$ millim. This square shape holds until the 182d joint, which is 2 millim. by 2 millim.; there the margin of the worm appears rather serrated, the posterior parts of each joint overlapping the next following. The worm now grows broader, and the joints shorten in the same proportion. The 260th joint measures $1\frac{3}{4}$ millim. in length by 3 millim. in breadth. The first evident genital opening we saw in the 309th joint, 325 millim. from the head; but in the 273d, traces of these openings were already visible as small protuberances on the margin, running out into a transverse fold over the joint. The 309th measured 2 millim. in length by 2 millim. in breadth, the diameter of the genital opening being nearly half a millimetre. No ripe eggs were yet to be found in this age of the joints. The first were found in the 365th joint (415 millim. from the head), but only a few, with many unripe ones. The worm now grows broader fast, and also thicker. The 448th (603 millim. from the head) is 8 millim. in breadth by 2 millim. in length, the

genital opening occupying nearly half of its length; the 569th (858 millim. from the head) is 10 millim. broad and 3½ millim. long; here the worm is the broadest, and the genital openings most marked, much more so than in the more mature joints which follow. Here, rather than in the proglottides, must the act of reproduction take place; and this leads us to consider the proglottides more as oöphores (egg-bearers). From this point to the end, the joints grow longer and narrower. The 680th joint (1348 millim. from the head) is nearly square, being 8 millim. broad and 7 millim. long; the 768th has already the longitudinal proglottis shape, being 14 millim. in length by only 6½ in breadth; the 849th (3198 millim. from the head) is even 17 millim. long and 4½ broad; the genital openings becoming less and less marked. The 856th and last joint is still a little shorter, and in this a genital opening is hardly visible.

The total length of this worm, which seems to be an entire specimen, is 3299 millim. (10 feet 9 inches).

The ripe eggs are globular, 0.036 millim. in diameter; but the joints of this specimen are remarkably poor in eggs; the middle trunk of the uterus, in particular, is rarely filled with them. In the square joints, about the 700th, the vagina is distinctly dark-colored, and the lateral branches of the uterus are nearly straight, transverse, parallel lines, and only about 10 in number. The calcareous granules in this worm are mostly oval; those in the long and ripe joints measure 0.012 millim. in breadth by 0.015 – 0.018 in length.

§ 60. I have seen yet another interesting specimen of human tapeworm, belonging to the museum of the Medical Improvement Society, Boston, (see Catalogue, by Dr. J. B. S. Jackson, under No. 895,) coming from a man about forty years of age, and expelled without medicine. The specimen was presented by Dr. John Homans. This worm is also remarkable *for the large size of its club-shaped head, and of its suckers, and in this case, also, I could see no trace of a muzzle;* its joints, particularly in the first half of the worm, are very short and broad, and there is throughout this worm a tendency *of the joints to divide on one or the other side into halves*, each half

bearing a genital opening. We hope to publish before long an accurate description and figure of this worm. The eggs are oval, smaller than in either *Tænia solium* or *Tænia mediocanellata*, measuring 0.030 millim. in length by 0.024 in breadth. Only one of about thirty eggs which I measured was 0.033 millim. long by 0.030 millim. in breadth.

§ 61. Where do these two Cestoidea (described in § 59 and § 60) belong? If it were not for the head, we should have had no hesitation whatever in placing them with *Tænia solium*, L.; for the chain of joints would not justify their separation from that species; yet the head is that of *Tænia mediocanellata*, as described by Küchenmeister. Do these worms belong to that third undescribed species of human Tænioid to which Küchenmeister alludes in his "Parasites of Man" (Vol. I. p. 89)? We shall treat further of this in the article on *Tænia mediocanellata* (§ 65).

§ 62. The hydatid of *Tænia solium*, L., *Cysticercus cellulosæ*, seems to be not much noticed in man in the United States. In the hog it is sometimes rather abundant. I understand that recently in one slaughter-house in New England twenty hogs at one time were found to be infected with measles, and the pork had to be thrown away in consequence.

I. b. *Tænia solium*, L. *Varietas abietina*, Weinland.

§ 63. Under this name I will introduce a specimen of tapeworm which came from a *Chippewa Indian*, at the Saut St. Marie, Lake Superior; it was obtained there by Prof. Agassiz, during his famous trip to that lake. The specimen consists of a chain

of several feet in length, from the mature part of the worm. The head, neck, and the whole anterior half, are wanting.

The most striking thing in this worm is its extreme narrowness and meagreness, while *Tænia mediocanellata,* which it resembles in the configuration of the uterus, is very broad and thick, according to Küchenmeister. A figure of this worm, of its uterus and eggs, we intend to publish in our work on the Parasites of Man.

All the joints which are preserved are very thin, nearly transparent, and equally narrow, their transverse diameter being about 4 millim., and the longitudinal about 12 millim. The genital openings are very small, and without external lips; this may be owing to the very mature age of the joints in question. There is no pigment in either vagina or spermatic duct. The uterus is more regular than either in *Tænia solium* or in *Tænia mediocanellata*, yet it more resembles the latter. The middle trunk of the uterus is quite straight; the branches, about 30 in number, start from the main stem, either at right angles or at an angle of about 45°. These branches are always quite parallel, and are generally straight; but whenever they are bent, all make the same angle; they are never arboreseently divided, nor fureated at the ends, with the exception of the foremost and the hindmost in each joint, which run, the former forwards, the latter backwards, both being forked and crooked. The eggs, which are extremely plenty in these joints, and which show the whole configuration of the uterus, in a yellowish tint, to the naked eye, are 0.033 millim. long and 0.030 millim. broad; they are protected, first, by an outside shell (*chorion*), which is 0.003 millim. thick, dark in its outer layers, transparent, yellowish inwards; then follows a second shell (yolk-membrane), 0.0006 millim. thick, entirely transparent. In the cavity of the egg lies the embryo, occupying about two thirds of it, and measuring only 0.016 millim. We saw other eggs, unripe, and with one egg-shell only, but very rarely.

We consider this worm merely as a variety of *Tænia solium*, and we called it *Varietas abietina*, from *abies*, a pine-tree, which the configuration of its uterus resembles.

We hope soon to get more information concerning this Indian tapeworm from our Western and Canadian medical friends.

I. c. *Tænia from the Cape of Good Hope.*

§ 64. Dr. Küchenmeister has described under this designation a human Cestoid coming from a *Hottentot*, at the Cape of Good Hope. The specimen consisted in a piece of several yards in length, but without head or neck. Küchenmeister is inclined to consider it as a distinct species. The joints are long, very thick, and all along them runs a crest. Something similar to such a crest has been found occasionally as a monstrosity in *Tænia solium;* and since the uterus, as figured by Küchenmeister, also resembles very much that of *Tænia solium*, its branches being arborescently divided, as is the case in the latter, we are inclined to consider this worm as a variety of *Tænia solium*, until further information as to the organization of its head shall be received. Leuckart thinks it might be *Tænia mediocanellata.*

I do not know of this variety having ever been noticed in negroes of the United States.

II. *Tænia mediocanellata*, Küchenmeister.

§ 65. In the year 1855 Küchenmeister first characterized this Cestoid as distinct from *Tænia solium*, L. The head is larger than in the latter, with very large, generally dark-colored suckers. There is no crown of hooks, nor even a muzzle in the middle between the suckers. The uterus has three times the number of lateral branches, which run parallel to each other and are never divided in a dendroid form, as in *Tænia so-*

lium. Moreover, *Tænia mediocanellata* is generally broader than the latter. The absence of the muzzle must, in our view, distinguish this worm not only specifically, but generically, from *Tænia solium*, and we would propose for this new genus the name *Tæniarhynchus* (derived from *Tænia*, *a* privativum, *without*, and ῥύγχος, *muzzle;* that is, *Tænia* without a muzzle). We shall below treat more fully of the supposed characters of this new genus. Küchenmeister saw this worm five times in his own practice in Zittau (Silesia, Germany); once he expelled it from himself. Only a few other cases besides these are known. But the specific distinctions are acknowledged by the best authorities (Joh. Müller, Gurlt, Eschricht, Rud. Leuckart, Van Beneden). Nothing is yet known as to the development of this worm. There is no hydatid known in which muzzle and hooks are wanting.

The perfect description of this species, as furnished by Küchenmeister, and the acknowledgment of its specific difference from *Tænia solium* by so good authorities, must justify us in the proposition of the new genus, *Tæniarhynchus*. Yet we cannot help expressing some doubts as to the true foundation of this species and genus. The diversity in the organization of the head, which exists between *Tænia mediocanellata* and *Tænia solium*, namely, the total absence of a muzzle and of hooks in the former, is so important, that these two species cannot be brought under one genus, in that sense in which *genus* is generally understood by zoölogists. But, on the other hand, this great diversity in the organization of the head seems not to be confirmed by differences in the rest of the organization of this worm. The diversity in the configuration of the uterus, which has been indicated by Dr. Küchenmeister, we should hardly be inclined to acknowledge even as specific. We have seen the number and the direction of the lateral branches of the uterus varying to a great extent in one and the same specimen of *Tænia solium*, in different parts of its chain.

Also the size of the eggs, and their more circular or more oval shape, often vary to some degree in one and the same Cestoid, as Küchenmeister himself is well aware. Moreover, we would remind our readers of the two Cestoidea described under § 59 and § 60, which both combine the head of *Tænia mediocanellata* with the uterus of *Tænia solium;* also of the fact, that no *Cysticercus* without muzzle and hooks has as yet been found.

These considerations suggested to us the question whether all these *Tæniarhynchi* (*Tæniæ* without a muzzle) might not be in fact true *Tæniæ*, which have lost their rostellum or muzzle in some unknown way, perhaps by being pressed by solid particles of the food which passes the intestine, and which might have forced the head of the *Tænia* out of its attachment, in such a way that the muzzle, being solidly fixed with its hooks in the walls of the intestine, would be torn off; while the remaining head, though deprived of its muzzle, would fix itself anew by means of its four suckers, which would then naturally enlarge, being now the only organs of attachment for the whole worm.

To test the question, we would suggest an experiment; namely, to feed a young, healthy hog with the proglottides of *Tænia mediocanellata.* If any Cysticerci are formed, the organization of their head will show whether the species *T. mediocanellata*, and consequently the genus *Tæniarhynchus*, are founded in nature or not.

§ 66. *Observations on Tænia mediocanellata in the United States.* — No *T. mediocanellata*, agreeing in every respect with the description of Küchenmeister, has yet, so far as I know, been noticed in this country. Besides the two Cestoides, however, already described (§ 59 and § 60), the heads of which resemble very much that of the species now under consideration, I have seen one specimen of a *Tænia* which, so far as it is preserved, answers well to the definition given by Küchenmeister of his *T. mediocanellata.* It came from a girl seven years old, whose mother was a mulatto and father a negro, living in Charleston, South Carolina. The specimen, which was obtained by Prof.

Agassiz from Dr. Gaillard of that city, is a portion of the anterior and immature half of the worm, torn off about a foot from the head. It very strikingly exhibits, in its anterior parts, the loose connection of the joints, which has been termed "rosary-like" (*paternoster-ähnlich*) by Küchenmeister, and which is considered by him as characteristic of *Tænia mediocanellata*. The joints are also more bulging at the sides than is usually observed in *T. solium*. The joints following are somewhat broader than they are in *Tænia solium* at the same stage of development; and the uterus has rather straight, but not very numerous branches. The joints being young, the eggs were not yet provided with their shells. We hope to hear more about this Cestoid from the Southern physicians.

III. *Tænia nana*, Von Siebold.

§ 67. This minute Cestoid has been found only once, but in large quantities, by Dr. Bilharz, in the small intestines of a boy in *Egypt*.

It is only one inch in length, its whole body filiform, the head blunt in front, tapering backwards, and provided with four suckers, and with a muzzle, bearing a crown of *bifid* hooklets.

"Bifid" hooklets are well known as being found in two genera of Cestoids which live in sharks and skates, viz. in *Onchobothrium* and in *Acanthobothrium;* but to these *Tænia nana* stands in no relation whatever. On the contrary, its four suckers, and the fact that its hooklets form a crown on a muzzle in the middle of the head, show it conclusively to be a real Tænioid. Now, there is no genus of this latter family known that has bifid hooklets, and we deem this character sufficiently typical to establish on it a new genus of Tænioids, under the name *Diplacanthus* (from διπλους, *double*, and ἄκανθα, *hook*, meaning double-hook.)

Nothing is known about the embryological development of this worm. Its small size, which reminds us somewhat of *Tænia echinococcus*, Siebold, and, moreover, the fact that it has been found by Bilharz in such great numbers in one intestine, has suggested the idea that its development might go through an Echinococcus-like hydatid, which, when accidentally swallowed by the boy, would naturally have given rise to the development of so many tapeworms at once; for Siebold found similar large numbers of *Tænia echinococcus* in a dog which he had fed with *Echinococcus veterinorum.*

In the United States this strange Cestoid has never as yet been noticed.

IV. *Hymenolepis* (*Tænia*) *flavopunctata*, Weinland.

§ 68. Among the helminthological specimens with which Dr. J. B. S. Jackson kindly furnished us, for further investigation, from the collection of the Medical Improvement Society, Boston, there was a phial containing a number of pieces of a small tapeworm. In the Catalogue of the Collection we find these specimens mentioned under No. 903, with the following words: "A (second) specimen of Bothriocephalus, three feet in length, and from half a line to one line and a quarter in width; from an infant. The joints are very regular, except at one extremity, where they approach the triangular form, are very delicate, and but slightly connected, as shown in a drawing by Dr. Wyman. From a very healthy infant nineteen months old; it had been weaned about six months, and had had the usual diet from that time. The worm was discharged without medicine, its presence

having never been suspected. 1842. Dr. Ezra Palmer, Jr."

It is probably owing to the regularity and shortness of the joints, that this worm, which evidently attracted the particular attention of the two learned gentlemen named above, was put in the Catalogue under *Bothriocephalus latus*, rather than under *Tænia solium*. Moreover, there is a yellowish spot, clearly visible to the naked eye, situated about the middle of each joint, which reminds us very much of the color and situation of the genital organs as known in *Bothriocephalus*.

A careful examination, however, has taught us that there were in that phial parts of at least six different specimens of a very characteristic tapeworm, belonging neither to the genus Bothriocephalus, nor to the genuine Tænias, — which latter, when limited in our sense, comprehend, besides *Tænia solium*, only tapeworms of carnivorous mammals,* — but to a group of

* It is an interesting question, how the Tæniæ of the different groups of Vertebrata are related to those of man. It would be expected that similar Tæniæ would live in similar animals. The following remarks relating to the natural classification of Tænioids will best show how far this rule holds good.

From a review of the genus *Tænia*, which in Dujardin's *Histoire Naturelle des Helminthes* (1845) numbers 145, and in Diesing's *Systema Helminthum* (1850) as many as 180 species, we have satisfied ourselves that this genus constitutes a natural family of the order of Cestoidea, which contains at least two very marked subfamilies, and a number of genera. Several modern helminthologists have perceived the great discrepancy of the different species which constitute the old genus Tænia, but the characters by which they have tried to divide it into several sections have failed to lead to natural groups. Thus Dujardin, by attributing too much systematic value to the situation of the genital openings, had to separate sometimes the next allied species, e. g. *Tænia scutigera* and *Tænia tiara*. The number of hooks, also, is of small systematic value, but the number of rows of hooks and the typical structure of the latter lead to some natural minor groups. The

Tænioids, whose members thus far had only been found in small omnivorous or insectivorous Mammalia

arrangement of Diesing, resting only upon the nature of the proboscis, is artificial, when carried through without reference to the rest of the organization, as is the case in his *Systema*. The configuration of the proboscis can be brought to bear upon the constitution of genera, only after other characters of physiological importance have established the subfamilies. Diesing was, however, the first who formed the family of *Tænioidea;* still he keeps under his genus *Tænia* all those which his predecessors had placed there. Van Beneden (*Bulletin de l'Académie Royale de Belgique*, Tom. XVI. No. 2), adopting the family "Tænioids," places there *Tænia*, *Halysis*, and *Triænophorus*. The latter genus we must remove entirely from the Tænioids on account of the different structure of its head; while the genus *Halysis*, based on the species *H. genettæ*, will probably fall under the genuine Tænias, so far as the description of this species by Gervais allows of a decision.

We will give in few words our results, mainly based upon numerous anatomical and embryological investigations of our own. We might briefly characterize the family of *Tænioidea* as Cestoidea with four suckers on the head, and with marginal genital openings. We have recognized thus far in this family two very distinct subfamilies, easily recognized by the characters of the egg-shells. The arrangement and structure of these latter being evidently connected with the place where and the circumstances under which the egg hatches (see § 47), this character has a true physiological value. These two subfamilies are: —

Subf. I. Scherolepidota (Hard-shell Tapeworms), with a hard, brittle, rather thick, and dark-colored egg-shell, more or less closely fitting to the embryo, the eggs small, averaging about 0.030 millim. in diameter. *These eggs are destined to hatch in the stomach of Vertebrata, and probably only of warm-blooded ones.* The full-grown tapeworms live exclusively in the intestinal canal of carnivorous Mammalia (and birds?). Here belong the following genera: — Gen. 1. *Tænia* (in a limited sense). With a uterus consisting of one median main-stem with lateral branches; the head with two rows of hooks, and these hooks of the type of *T. solium*. The development goes through a Cysticercus or Cœnurus form. Here belong *T. solium* of man, *T. intermedia* of the marten, *T. serrata* of the dog, *T. crassiceps* of the fox, *T. crassicollis* of the cat, *T. laticollis* of the lynx, *T. polyacantha* of the fox, *T. e Cysticerco tenuicolli* of the dog, *T. Cœnurus* of the dog, and probably also *T. tenuicollis* from the weasel. — Gen. 2. *Acanthotrias*, Weinl. (see § 79). With three rows of hooks. Development through Cysticercus. — Gen. 3. *Tæniarhynchus*, Weinl. (see § 65), with *Tænia mediocanellata*. Development no doubt through Cysticercus. —

(mice, shrew-mice, etc.) and birds. It is widely different from *Tænia solium*, and its true congeners, in the

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Gen. 4. *Echinococcifer*, WEINL. (see § 74). Small and delicate tapeworms, with two rows of exceedingly small hooklets. Development through Echinococcus. Here belong *Tænia Echinococcus*, SIEBOLD; and the Tænia of *Echinococcus hominis*, RUDOLPHI, unknown to this day. Whether *Polycephalus hominis*, ZEDER (*Nachtrag*, p. 309, tab. 2, fig. 5–7), really belongs to *Echinococcus hominis*, as Rudolphi thinks, and whom all helminthologists have since followed, seems to us rather doubtful, since Zeder — certainly a good observer — speaks expressly of only *one* row of hooklets. — Gen. 5. *Diplacanthus*, WEINL. (see § 67). Small tapeworms, with a crown of bifid hooklets; with *Tænia nana*, SIEBOLD. Development unknown. This genus might belong to the next subfamily.

Subf. II. MALACOLEPIDOTA (Soft-shell Tapeworms). In this group, which contains far the greater part of the Tænioids, the outer shell of the egg is thin and transparent, either elastic and membranaceous, or mucilaginous. The diameter of the cavity formed by this outer egg-shell is much larger than that of the embryo. The average size of these eggs is 0.06 millim. *The eggs of these tapeworms are to be hatched in the stomach of Invertebrata, either of Articulata or of Mollusks.* The full-grown tapeworms live in the intestinal canal of warm or of cold-blooded Vertebrata, which feed upon or swallow accidentally insects, snails, etc. There are a number of genera in this subfamily, of which I will mention the principal: — Gen. 1. *Hymenolepis*, WEINL. (see § 68). (The name is derived from *ὑμήν*, *membrane*, and *λεπίς*, *egg-shell*.) The outer shell of the egg membranaceous; one, rarely two rows of small hooklets on the proboscis. The hooklets much less developed than in the Sclerolepidota. Uterus consisting of ball-like blind sacs. The Tænioids belonging to this genus live in insectivorous Mammalia and birds, and we may distinguish two subgenera, which separate pretty well those of the Mammalia from those of the birds, viz.: Subg. 1. *Lepidotrias*, WEINL. (derived from *λεπίς*, *egg-shell*, and *τρεῖς*, *three*), with three egg-shells. Nearly all the species living in small insectivorous Mammalia. As the type we may consider *Tænia murina*, DUJARDIN; and besides this belong here *Tænia scalaris*, *T. scutigera*, *T. tiara*, *T. pistillum*, *T. microstoma*, *T. nasuta*, *T. undulata*, *T. serpentulus*, *T. crateriformis*, *T. sinuosa*, and *Hymenolepis flavopunctata*. Further particulars in reference to this group are given above in the text. Subg. 2. *Dilepis*, WEINL. (derived from *δύο*, *two*, and *λεπίς*, *egg-shell*). The egg has two shells only; the outer shell is membranaceous, and often bears strange appendages. The tapeworms of this subgenus live particularly in insectivorous birds, and we may consider *Tænia angulata*, RUDOLPHI, as its type. Here belong *Tænia purpurata*, *T. porosa*, *T. lanceolata*, the Tænioid of the

structure of its eggs, the situation of its genital openings, etc.

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golden-winged woodpecker, mentioned above, § 28, and probably many other insufficiently described species, the eggs of which have not yet been studied. — Gen. 2. *Proteocephalus*, Weinl. (The name is derived from Πρώτευς, the ever-changing principle in the old Greek mythology, and κεφαλή, *head*.) The shape of the head of this genus is extremely changeable. There is no proboscis, nor hooklets. The eggs are provided with two shells, the outer shell being mucilaginous. These Tænioids live in reptiles and fishes. The type of the genus is *Tænia ambigua*, Dujardin. Here belong *Tænia filicollis* and *T. dispar*. — Gen. 3. *Alyselminthus*, Zeder, in a confined sense including only the *Tænia cucumerina* of the dog. Small spines, arranged in a series of rows, and these spines having a flat foot, characterize this genus. Its eggs have simple and very thin shells, and are deposited in lumps, a number of them glued together into an oval mass.

There are other genera yet to be established in this subfamily, but the Tænioids which belong to them have not been sufficiently studied to permit a comparison of the characteristic features on which to base the genera.

When applying this systematic review to the question of which we first spoke in this note, we find that all species of Tænioids which live as mature tapeworms in the human intestine, are peculiar to man; further, that all these Tænioids belong, with one exception, to the subfamily *Sclerolepidota;* that the *Tænia solium* belongs to the same genus with tapeworms found in dogs and other carnivorous animals; that two sorts of tapeworms of man, *Tænia mediocanellata* and *Tænia nana*, form, thus far, genera by themselves; finally, that only one tapeworm found in man belongs to the subfamily of *Malacolepidota*, viz. *Hymenolepis flavopunctata*, the congeners of which live in small insectivorous Mammalia. Of the five species of larval tapeworms found in man, only one (*Cysticercus acanthotrias*) is peculiar to man, and this has been found only once. The other four are met with also in domesticated Ruminants and Pachyderms and moreover in the liver, lungs, etc. of monkeys which are kept in captivity.

There are but two mature Tænioids known as living in the intestines of monkeys, *Tænia rugosa* and *T. megastoma*, both described by Diesing from alcoholic specimens. Their eggs or the structure of the uterus not being mentioned, we cannot place them in the above system. These worms came from South-American monkeys, belonging to the genus *Cebus*, and these monkeys being noted insect-eaters, I would venture to predict that their tapeworms are *Malacolepidota*. The specimens described by Diesing are preserved in the splendid helminthological collection of Vienna, of the richness of which we may form an idea from the fact that within fifteen years not less than forty-five thousand Vertebrates have been dissected there, in search of Helminthes.

All specimens of this worm which came under my eye were broken, and unluckily there was not one that had its head and neck, though I saw several pieces which must have come from quite near the neck.

The length of the whole worm is between 200 and 300 millim., that is, from 8 to 12 inches. There were pieces of 50 millim. in length, consisting of very young joints, only $\frac{1}{5}$ millim. long and 1 to $1\frac{1}{4}$ millim. broad; again, other pieces, about 100 millim. long, consisting in their anterior half of white, immature joints, $\frac{1}{3}-\frac{1}{2}$ millim. long and $1\frac{1}{2}-2$ millim. broad, while the mature joints of the posterior half, which are of a grayish tint (produced by the eggs which they contain), average 1 millim. in length and $1\frac{1}{2}-2$ in breadth. In the young joints the sides form straight lines, the transverse diameter being equal throughout the joint; in the riper ones they are round and bulged, and the transverse diameter is the greatest in the midst of each joint. One of the pieces which is especially mentioned in the Catalogue of Dr. J. B. S. Jackson, shows the form of the joints when fully matured and soon to be freed as proglottides. They are in this specimen triangular in shape, being narrow in front and suddenly broadening behind, evidently having already discharged the eggs from the anterior part of the joint, while generally proglottides deposit their eggs only after they are free. In other specimens these last joints, being yet quite full of eggs, are more oblong, even with the transverse diameter longer than the longitudinal. In either case the proglottides are very loosely connected with each other. In relation to the genital organs, we have mentioned above the yellowish spot lying near the middle line in the anterior part of each joint, and it is for this that we have called the species *flavopunctata*. These spots are the testicles, appearing under the microscope as a globular gland, with another smaller one attached to it; this latter one runs out, towards the side of the joint, into a long, slender canal, in which lies the penis. The genital openings are situated all on one and the same side of the worm, while in all true Tænias (see page 51, note) known thus far, they are found irregularly, now on one, now on the other side. The configuration of the uterus, also, differs greatly from that in the genuine Tænias. There is no main-stem in the midst with lateral branches,

as in the latter; but, on the contrary, the eggs are crowded over the whole joint. It sometimes appears as if they were arranged in straight lines along the joint; but this is certainly owing only to the regular lines of muscular contractions. Only fresh specimens can decide ultimately the structure of the uterus. From a careful dissection of the younger joints, we should judge that it consists of globular blind sacs, located here and there in the joint, and connected by fine tubes terminating finally in the vagina. The most characteristic feature in this worm is its eggs, the number of which may be counted by thousands in each ripe joint. They are very large, measuring 0.054 millim. in diameter, and under a low power of the microscope appear as transparent balls with a yellow dot in them. With a higher power, we easily distinguish three distinct egg-shells (Fig. 9. 1, *a*, *b*, *c*). The outside shell is translucent, elastic, cracking in sharp angles under pressure, and only 0.0007 millim. thick; this shell is folded by application of glycerine. The second shell is membranaceous and irregularly wrinkled, thinner than the first, and immediately attached to it. This second shell, showing through the first, gives to the whole surface of the egg a wrinkled appearance, though the first shell is in reality entirely smooth. The large cavity which is formed by these two outside shells contains a fluid,* in which swims the small globular embryo (measuring only 0.024 millim.), enclosed in a third shell, closely attached to it, but of considerable thickness (0.001 millim.). We cannot state with certainty that there are three pairs of spines to this embryo; if there are any, they must be very small.

Fig. 9.

A very similar arrangement and structure of the egg-shells, as described above, have been noticed by the French helminthologist, Dujardin, in his *Tænia scalaris*, from a European shrew-mouse (*Sorex*

* This fluid, which has the appearance of albumen, turns milk-white when brought in contact with water. Such an albuminous fluid between the two egg-shells has also been noticed by Dujardin in the eggs of a Tænioid from *Fringilla domestica*, L.

Fig. 9. 1. Egg of *Hymenolepis flavopunctata*, 350 times magnified. *a*. Outer egg-shell. *b*. Middle egg-shell (wrinkled). *c*. Inner egg-shell, enclosing the embryo, *d*. 2. Egg of *Bothriocephalus latus*. 3. Egg of *Tænia solium*.

araneus), in his *T. scutigera*, from another shrew-mouse (*Sorex tetragonurus*), in his *T. tiara*, from the same, in his *T. murina*, from the common rat, and in his *T. microstoma*, from the house-mouse. All these Tænioids are small, like ours, and even of less size; their joints have about the same proportions, and all of them, with one exception, have, like ours, the genital openings all on one and the same side, though we do not deem this latter character of so great systematic value as the distinguished microscopist of Rennes. But it is particularly the arrangement and structure of the egg-shells that bring them, with the Tænioid under consideration, evidently under one group, which we have considered in our classification of Tænioids (see the note on page 52) as a subgenus of *Hymenolepis*, and called *Lepidotrias*, from the three egg-shells, in contradistinction from the subgenus *Dilepis*, which has but two. The fact that all the species mentioned above, as described by Dujardin, have but one row of rather small hooks, provided with a long foot and sharp spine, varying in number in the different species from twelve to thirty, leads us to predict a similar arrangement of the crown of hooks in our species.

This small tapeworm might sometimes occur in man without being noticed,* and we call the attention of physicians to it more from its scientific interest, than on account of any pathological effects produced by it, which probably amount to nothing, so long as only a few inhabit the intestine.

In relation to the question how man can become infested with this tapeworm, and particularly how the child above mentioned could have become so, who perhaps had never eaten any meat, we would venture the following hypothesis. We will remind the reader of

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* Pallas, in his *Neue Nordische Beiträge* (I. 1, p. 69, tab. 2, Fig. 19, A. B. T.), mentions and figures a *Tænia tenella*, which by Rudolphi has been referred to *Bothriocephalus latus*, and has since entirely disappeared from helminthological literature. Is this our *Hymenolepis*, or some Cestoid like it? I cannot decide the question, not having the book of Pallas at my command.

the tapeworm larvæ found in the walls of the stomach of the meal-beetle (*Tenebrio molitor*), of which we spoke above (§ 44); after this discovery of Stein there seems to be hardly any doubt left that the shrew-mice, which live only upon insects, get their tapeworms from insects in which such tapeworm larvæ live, and so, very likely, do also the insectivorous birds, the tapeworms of many of which have egg-shells of a similar structure with the Cestoid under consideration.* Hence we suggest the possibility that this child also may have become infested with its tapeworms by swallowing accidentally a fly, or other insect, which contained a number of the hydatids of *Hymenolepis flavopunctata*.

V. *Bothriocephalus latus*, Bremser.

Tænia lata, Linne.—*Dibothrium latum*, Rudolphi, Diesing.

§ 69. The genus *Bothriocephalus* belongs to the family *Dibothria*, Diesing. The head of this genus is rather flat, without the four circular suckers found in Tænioids, and without a real muzzle capable of insertion, but provided with a small sucking disc on the top of the head, and with two lateral longitudinal grooves, by which the worm adheres to the walls of the intestine. Its genital openings are not situated on the margin, as in Tænia, but on the median line of the belly of each joint. There is a distinct opening for each of the sexes; the penis, lying in front, is easily visible with the naked eye. The eggs (Fig. 10. 2) are oval,

* I suspect that the scolex of *Tænia cucumerina* of the dog, the development of which is yet unknown, inhabits the flies which the dogs are so eager to catch and to swallow.

covered with one egg-shell only. *B. latus* is the only species of this genus which lives in a member of the class of *Mammalia*,* and this is found in man only. Nearly all other species of *Bothriocephalus* live in fishes and reptiles, and the rest in water-birds. This Cestoid is, as its specific name signifies, broad, — broader than *Tænia solium;* the joints are also more solidly connected, shorter, and the skin more resistant. It reaches a length of twenty feet, and a breadth of more than half an inch, sometimes of nearly an inch.

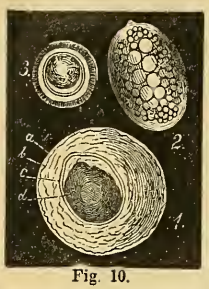

Fig. 10.

The development of this worm, and therefore the way in which it reaches the human intestine, are unknown. The idea of Küchenmeister, that its hydatid may live in small snails (*Limax*), which live on lettuce, and which no doubt are often accidentally swallowed by man with salad, is certainly worthy of further investigation.

B. latus is rather common in Switzerland, and among Sclavonic nations, particularly the Russians. It is a fact worth mentioning, that it does not generally occur where *Tænia solium* is relatively common, as in Germany, in England, and in the United States. The opinion once in vogue, that this tapeworm in Switzerland might be transferred from one person

* It seems to be an exceptional, but not the less interesting case, that Creplin once found a *Bothriocephalus* in a cat, which, as he suspected, may have been infested with it by eating fish containing the larva of that worm. See Creplin, *Observationes de Entozois*, p. 67, fig. 9.

Fig. 10. Eggs of three different human tapeworms, 350 times magnified. 1. Egg of *Hymenolepis* (*Tænia*) *flavopunctata*, Weinland. 2. Egg of *Bothriocephalus latus*, Bremser. 3. Egg of *Tænia solium*, Linne.

into another immediately by the eggs, founded on the fact that the Swiss, who eat lettuce raw as salad, often manure this plant from their vaults, is certainly erroneous, and probably long since given up by its author (C. Vogt). As soon as the development of other tapeworms was known, such a theory could no longer stand; but it still lingers here and there, even among scientific men who are not acquainted with the present state of helminthology. It is clear, from all that has been said as to the development of tapeworms, that the eggs of *Bothriocephalus*, when swallowed by man, might produce a kind of hydatid in the muscles or other tissues, but that they never could be developed immediately into tapeworms in the intestine. The remedies against this worm are the same as those against *Tænia solium*. (See Chapter IV.)

§ 70. *Observations on Bothriocephalus latus in the United States.*—We have seen two specimens of this worm in this country; the first was expelled from a Swiss soon after his arrival in the country The second was from an Englishman, in Richmond, Va., who had perhaps travelled in Switzerland, and, like the German anatomist and physiologist, Soemmering, and many other travellers, brought away with him this *vade-mecum* from the land of William Tell. We have never yet seen a specimen which came from an American, nor has Prof. Leidy of Philadelphia, as he informs us by letter.

B. — Larvæ of Tapeworms inhabiting various Tissues of the Human Body.

I. *Cysticercus cellulosæ*, Rudolphi.

§ 71. Of this larva of *Tænia solium*, L., we have treated above, in the article on that Cestoid. On its occurrence in man, see § 55. For the symptoms, and the protection from it, see § 57. Its cure is treated of in the fourth chapter, at the beginning. On its occurrence in the United States, see under § 62. In regard to the nature and organization of the Cysticercus in general, we refer our readers to Chapter II. of this treatise, especially §§ 35, 41, 44.

II. *Cysticercus tenuicollis*, Rudolphi.

§ 72. This hydatid is rather common in the mesentery of the Ruminants, and of hogs, horses, squirrels, monkeys, etc. It has been found, in some rare instances, attached to the liver and mesentery of man. Its length is about twenty millimetres; its breadth, about ten. It ends in a bladder of from one to six inches in diameter (always larger than in *C. cellulosæ*).

Cysticercus tenuicollis is the larva of a tapeworm of the dog, very likely *Tænia marginata*, Batsch, as R. Leuckart supposed, which is closely allied to the *T. solium* of man. It is provided with two rows of hooks, from sixteen to nineteen in a row, the hooks of one row being larger than those of the other.

Eggs of *T. marginata* accidentally swallowed by man would produce the hydatid in question, which latter, again, when eaten by the dog, would develop itself in the intestine of this animal into the above Tænia.

Luschka, Leuckart, and Roell have fed goats and sheep with the mature proglottides of this tapeworm, (which is the most simple way of getting many eggs at once safely into the stomach of the animal on which the experiment is made,) and on dissection found this hydatid.

§ 73. *Observations on Cysticercus tenuicollis in the United States.*—Prof. Leidy notices this worm, in his Synopsis of Entozoa, as found "occasionally in the liver of the hog and in the mesentery of the sheep."

III. *Echinococcus Veterinorum*, Rudolphi.

Echinococcus scoliciparíens, Küchenmeister.

§ 74. We refer to what we have said above (§ 36) on *Echinococcus* generally, and on the genus *Echinococcifer* (page 52, note). The species in question occurs rarely in man, but is rather frequent in the liver and lungs of Ruminants, where it forms bladders of more than an inch in diameter. The full-grown Tænia (*T. echinococcus*, Siebold) lives in the dog, often by thousands. It has but three joints, and is only an eighth of an inch long. Its head is provided with two rows of hooklets, from fourteen to eighteen in each row. These hooklets are exceedingly small, being only one sixth of the length of those of *T. solium*.

In this large hydatid we notice the scolices swimming free in its fluid, and visible to the naked eye as small, white granules. These scolices bud from the inside of little cystes, of the size of a millet-grain, which themselves originate on the inside walls of the Echinococcus; and this latter we might call, in this case, the primary or mother hydatid. In each of the cystes originate a number of scolices; after these are ripe, the cystes burst, and the young larvæ now swim free in the fluid of the Echinococcus. They cannot, however, as it seems, live long in this state, and if they do not reach the

stomach and intestine of a dog, they die. Thus we always find in such an Echinococcus many dead scolices, and hooks of others which have already decayed. It seems that sometimes the scolices bud out immediately from the inside of the walls of the Echinococcus, without the intervention of cystes. Huxley even saw such scolices growing on the outside of these secondary cystes.

Siebold, giving this Echinococcus, taken from Ruminants, to dogs, raised its Tænia in great quantities. It was mature seven weeks after being swallowed. The precaution to be used against this Echinococcus is theoretically plain enough; namely, to keep clear of the eggs of that tapeworm. Butchers' dogs are most likely, of all dogs, to be afflicted with *Tænia Echinococcus*, since they have frequent opportunities of eating the Echinococcus bladders found in the lungs and livers of Ruminants. We therefore warn butchers not to give these bladders from the lungs or livers of oxen, etc. to their dogs. The eggs of this tapeworm, which are probably not rare in the excrements of butchers' dogs, may get into the stomach of Ruminants, and occasionally of man, by drinking water, or by eating vegetables or fruits which have lain on the ground.

§ 75. *Observations on Echinococcus Veterinorum in the United States.* — I have never yet met with this hydatid in this country. Prof. Leidy,* in referring to this† (or to the next following?) species, says: "From

* See "A Synopsis of Entozoa," etc., in Proc. Acad. Nat. Sci. Phil., Vol. VIII. p. 45.

† Leidy uses the name *Echinococcus granulosus*, Rud., which is synonymous with *E. Veterinorum*, Rud., according to Rudolphi himself; but at the same time quotes as a synonyme *E. polymorphus*, Diesing, which comprehends both species, *E. Veterinorum* and *E. hominis*. Thus I suspect that my learned friend believed (with Diesing) in the identity of these two species; and this makes it doubtful to which species he refers. As to the difference of the two species (see § 76), there can be no longer any doubt, since the investigations of Küchenmeister and Leuckart.

a cyst, of about three inches in diameter, between the muscles on the right side of the abdomen, in an English sailor-boy; and also in two large cysts in the liver of a Frenchman. I have never met with this parasite in the Anglo-American. In three large cysts in the liver of a large species of monkey (species unknown), the specimen being preserved in the collection of the University."

IV. *Echinococcus hominis*, Rudolphi.

Echinococcus altriciparíens, Küchenmeister.

§ 76. This hydatid, which when sterile (without scolices inside) is often called an *Acephalocyste*, lives in different organs of man and domesticated animals. The tapeworm whose larva it is, is not yet known; most probably it also lives in the dog. The scolex of this *Echinococcus* is easily distinguished from that of *E. Veterinorum* by a larger number of hooks, viz. from twenty-three to twenty-six in each row; their shape is also different, while the size is about the same in both species. Moreover, *E. hominis* exhibits a different development of the scolices. In the fluid of the *E. hominis* we find other smaller (secondary) bladders swimming free. In these secondary bladders, again, we find tertiary ones, and it is only in the last that the scolex is formed. If, as we think probable, the tapeworm of this hydatid lives in the dog, or any other of our domesticated animals, the precaution against it would of course be the same as in *E. Veterinorum*.

§ 77. This is the hydatid that produces those horrible diseases amongst the Icelanders. *Dr. Schleissner*

found in some parts of the island, on an average, two or three members of each family infested, and Dr. Thorstensen says that about every seventh man in Iceland has this disease. It is found there in the liver, the lungs, kidneys, scrotum, spleen, ovaries, breasts, bones, etc., and often reaches the size of a child's head.

§ 78. *Observations on Echinococcus hominis in the United States.* — One or all the cases of Prof. Leidy (§ 75) might belong here. In the extracts from the records of the Boston Society for Medical Improvement I find, under Sept. 28, 1857, a case of *Echinococcus* in the lungs reported by Dr. Ellis. This hydatid was one inch long. "Concentric corpuscules" are mentioned as swimming in the fluid of the bladder. Are these the secondary bladders with tertiary ones inside? If this be the case, this *Echinococcus* was *E. hominis*. Other cases of *Echinococcus* of man, mentioned in different medical journals of this country, I am at a loss to refer to either of the two species, for want of accurate data.

V. *Cysticercus acanthotrias*, Weinland.

§ 79. In Prof. J. B. S. Jackson's Catalogue of the Collection of the Boston Medical Improvement Society, we read, under No. 904: "A *Cysticercus cellulosæ*, from a woman about fifty years of age, who died of phthisis, a dissecting-room subject at Richmond, Va. About a dozen or fifteen of the cysts were found in the cellular membrane of the muscles and in the integuments, besides one which hung free from the inner surface of the dura mater near the crista galli. In the same subject there were also numerous speci-

mens of *Trichina spiralis*." From Dr. Jeffries Wyman, 1845.

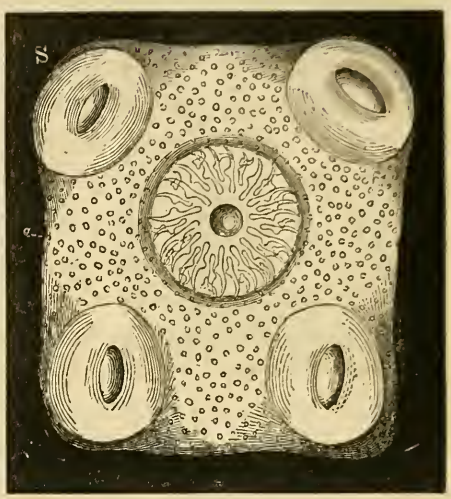

Fig. 11.

By a careful microscopic investigation of this worm, I found, to my astonishment, not two, but *three* rows of hooks on the proboscis, though the typical shape of the hooks is in general the same as in *Tænia solium* of man, in *T. crassicollis* of the cat, and in *T. serrata* of the dog, which have only two rows. From a systematic review of the family of Tænioids (see § 68, note), we are inclined to consider this as a generic character, and we base upon it a new genus, *Acanthotrias*, derived from ἄκανθα, *hook*, and τρεῖς, *three*. This genus comes next to the genuine Tænias, as the latter genus is defined in the place just referred to.

There are fourteen hooks to each of the three rows, and the hooks of the different rows are different in size and shape. The row of largest hooks (see Fig. 11 and Fig. 12. 1) is the innermost, when the muzzle is stretched out; these resemble the large ones of the true Tæniæ; their total length is 0.153 millim., the length of their foot, as I call that part which, being inservient to a firm hold, is buried in the tissue of the muzzle, is 0.090 millim. The hooks

Fig. 11. Head of *Cysticercus acanthotrias*, WEINLAND. About fifty times magnified. Seen from above. The head is flattened by the pressure of the covering glass, in order to show the four suckers (*S*), and the threefold crown of hooklets in the middle. The dark spot in the centre is not a hole, but merely a pit. *a*. Lime-globules. See under § 22.

of the next or second row (Fig. 12. 2), standing between those of the first row, and projecting with their thorns (that is, the free part of the hooks) a little beyond the thorns of the former, are a good deal smaller, but of the same general shape; their total length is 0.114 millim., and the length of their foot 0.063 millim. The hooks of the third row (Fig. 12. 3), lying outermost, yet between the two former rows, are far the smallest, their thorns are more curved, and their feet are much shorter; their length is 0.063 millim., and the length of the foot only 0.030 millim. The calcareous bodies in the skin of the worm (Fig. 11, *a*) measure 0.003 to 0.009 millim. The length of the whole Cysticercus is about 10 millim., without the bladder, which latter is of about the same size as in *C. cellulosæ*. The suckers of the head are visible to the naked eye. The neck is irregularly scalloped close to the head; at a distance of 5 millim. from the head the worm grows suddenly broader, and there are distinct folds running transversely over the worm, dividing this part into distinct joints. To this broader part is attached the bladder, by a narrow bridge. The cystes which contain this *Cysticercus* have exactly the same appearance as those of *Cysticercus cellulosæ;* looking somewhat like white beans, they lie along the fibres in the muscles, splitting them in such a manner as to make a gap before and behind the cyst, which is filled out with yellow fat. We hope to publish in another place drawings further illustrating this Cysticercus.

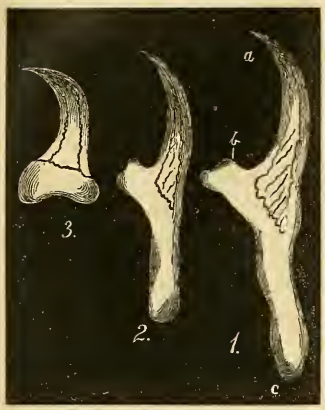

Fig. 12.

This hydatid came from a white woman. In the first public notice which was given of this worm, in the Boston Society of Natural History (October,

Fig. 12. Hooklets of *Cysticercus acanthotrias*. 350 times magnified. 1. A hooklet of the innermost row. From *a* to *b*, *Thorn* of the hooklet; this part bores into the walls of the intestine, when the worm attaches itself. From *b* to *c*, *Foot* of the hooklet, which lies in the muscular tissue of the muzzle of the worm. 2. A hooklet of the middle row. 3. A hooklet of the outermost row. The short and thick foot of these latter hooklets is characteristic of the genus *Acanthotrias*.

1857), it was left doubtful whether she was a white or a negro. Afterwards Dr. J. Wyman found a note in his diary relating to it, which enabled him to state with certainty that it was from a *white* person. We would earnestly suggest that Virginian and other Southern physicians should keep a look-out especially for the mature tapeworm (now unknown) of this interesting hydatid, which may live in the intestine of man, or perhaps in that of the dog.

§ 80. All human Cestoidea known up to the present day have been mentioned in the foregoing pages. Evidently we know those of a few nations of men only, and an extensive and interesting field is here open for the physician, naturalist, and ethnologist; particularly in this vast country, where so many nations meet.

The materials which have been subject to our observation, though furnishing some new and important data, were far too few to bring the investigation of the human Cestoidea of the United States to a close. I am free to say, that all that has been published by Prof. Joseph Leidy and by myself on this subject is hardly more than a commencement, when compared with what has been done in this respect in Europe, where Goeze, Zeder, Bloch, Pallas, Bremser, and especially Rudolphi, had laid the foundation of helminthology at the latter part of the last and the beginning of this century, and where many of the ablest observers of our day, as J. Müller, Von Siebold, Owen, Eschricht, Dujardin, Delle Chiaje, Nordmann, Van Beneden, Leuckart, Stein, Meissner, Wagener, Huxley, Blanchard, Küchenmeister, Gurlt, Diesing, Luschka, De Filippi, De la Valette, etc. have spent

years of time and labor in difficult helminthological researches.

I here call upon the physicians of America to keep a look-out for these human Helminthes, and particularly for the Cestoids, which are the least known of all; to investigate their head especially, to measure the hooks and eggs accurately with the micrometer, and to describe the uterus of the mature worms, as long as they are fresh. Should any one have no good microscope at hand, or other means of investigation, I would beg of him the use of his specimens, rather than that they should go unexamined. I would also particularly solicit specimens of hydatids, not only those from man, but also those from domesticated animals, as hogs, sheep, cattle, and rabbits, because some of the Cestoids of these animals are genetically connected with those of man, as is manifest from the foregoing pages. It is important, in an ethnological point of view, that the physicians in the South should pay some attention to the Helminthes of the Negroes; those in the North and West, to those of the Indians; and those in California, to those of the Chinese. I would also especially apply to the physicians and surgeons in the United States Navy and Army, of whose exertions in behalf of medical science the author had ten years ago heard in the lecture-rooms of a German university, to make observations in this respect, and to collect specimens, with accurate labels as to place, person, time, etc.

All Helminthes may be preserved in alcohol of fifty per cent; but the alcohol ought to be changed at least once.

Any specimens received for investigation, I pledge myself to return, if it is desired, or to send them to whatever public collection the donor may wish.

CHAPTER IV.

PATHOLOGY AND THERAPY OF HUMAN TAPEWORMS.

§ 81. We have mentioned already, in the preceding pages, many facts which bear upon the subject of this chapter. The *protection* from these parasites, and the places in the human body where they are to be expected, are evident from the natural history and development of each species, as given in the three foregoing chapters, and particularly in the last. Thus it remains only to speak of the pathological symptoms, and of the therapeutic treatment of persons who are infested with these parasites.

Pathology and Therapy of Hydatids.

§ 82. We must necessarily be short in respect to the *hydatids*, or larvæ of tapeworms, which are found in man, little of importance being known in regard to their cure.

§ 83. The *Cysticercus cellulosæ* has been observed a number of times in the subcutaneous areolar tissue of man, in various muscles, in the heart, and, moreover, in the eye and in the brain. In the first-named locality, as well as in the muscles, it is not much to be feared, if the number is not excessively large; in the muscle of the heart, however, it may lead to the formation of aneurisms, and to death in consequence. In the eye, where we once saw it ourselves, in a Prus-

sian mechanic, it produces temporary inflammation and loss of sight. In the brain it may lead to the formation of tubercles, or, by pressure, to other dangerous symptoms, and finally to death.* The cure is in most cases difficult, often impossible. The administration of vermifuges internally has failed; the remedies which are sure to kill or drive off the ripe tapeworms, which live in the intestine, have no influence on these hydatids.† The only therapeutic treatment, therefore, consists in a removal of these hydatids by the knife, or, if this be impracticable, in a puncture of the bladder with the needle, in order to kill the worm, either by bereaving it of its nutritive fluid, contained in its bladder, or by producing an inflammation in the cyst by which the hydatid is enveloped; for an inflammation of those parts of the human body which immediately surround the hydatid seems always to be fatal to the parasite. In hogs and other animals, such hydatids are not rarely found dead, their body changed into a calcareous mass, their tail-bladder shrunk and dried, but the different parts showing yet by their outlines the former Helminth.

§ 84. What was said in the foregoing paragraph in reference to the symptoms caused by *Cysticercus cellulosæ*, holds good for the other hydatids which are

* Brera (Verminous Diseases, p. 41) gives a full description of such a case, with a good figure of the diseased brain on Pl. III., and another, less exact, of the hydatid, Pl. II. Fig. 9. Ludwig (*De Hydrope Cerebri Puerorum*) says that, in *Hydrocephalus internus* of children, hydatids are often found in the brain.

† The fact that the wild boar, which is very fond of ferns, is hardly ever found measly, might lead to the theory that the ferns prevent the formation of these hydatids (measles); but we should rather think that the wild boar is less affected with measles because its chances of getting the eggs of the human tapeworm are very rare.

found in man; not only for *Cysticercus acanthotrias* and *tenuicollis*, but also for the two species of *Echinococcus*. The only difference is, that the considerable size of the three latter may endanger the neighboring organs by pressure more than *Cysticercus cellulosæ*. Thus *Cysticercus tenuicollis*, living in the mesentery, the liver, etc., might produce dropsy in the abdomen. We must, in general, remark, that the symptoms necessarily vary very much, according to the locality in which the parasite is placed, and that probably all the evil effects are to be attributed to the mechanical pressure of the hydatid bladder upon the neighboring organs, particularly upon the blood-vessels and nerves. Consequently the symptoms are the same as those arising from common tumors, for which we can refer to any hand-book on Pathology. The motions of these parasites seem to be very limited, and not sufficient to produce inflammatory symptoms.

As to the remedies against *Cysticercus tenuicollis* and *acanthotrias*, we can only repeat what has been said above (§ 83) in relation to *Cysticercus cellulosæ*. In reference to *Echinococcus hominis*, which seems to be the most frequent hydatid in man (see §§ 76, 77), we have to add, that the Echinococcus bladder, while in its place in the human body, often bursts (whether by external mechanical pressure or by its nature we are at a loss to decide), and thus pours out its serous fluid with hundreds of hydatids, or *scolices* (see § 76). Often the bladder is lodged so superficially as to discharge its contents immediately outwards through an artificial hole in the integuments of the body, a partial absorption of these latter having taken place

by the constant pressure of the bladder from the inside. But in most cases the Echinococcus is lodged deeper in the human body, particularly in the abdomen. Yet even then they may be discharged, and perfect recovery of the patient may follow. Scolices coming from an Echinococcus bladder lodged in the lungs, will be coughed up when the bladder bursts; from a bladder seated in the liver or in the walls of the intestines, scolices may come off with the evacuations; from an Echinococcus seated in the kidneys or in the walls of the urinary bladder, they may be discharged with the urine;* from one settled in the walls of the uterus, they may come off through the vagina. Even in cases where the Echinococcus is not settled in the organ itself which is connected with a natural passage outwards, as those mentioned above, but only near it, the discharge may yet be effected through those natural ways by the intervention of artificial passages, which are formed by pressure, and consequent absorption, of the intervening organs. The discharge of the scolices is generally followed by recovery of the patient; and there can be hardly any question that the bladder cannot originate new scolices after it has once burst.

From the natural history of these hydatids, as given above, it would appear well always to destroy, by fire or alcohol, the hydatids which have been removed, in order to prevent their further development into mature tapeworms.

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* Here also probably belongs the *Cysticercus vesicæ hominis*, CREPLIN, described in Joh. Müller's *Archiv*, *Jahrgang* 1840, p. 149. A girl in Pommern (Prussia), twenty-two years of age, discharged every fifth or sixth day, under symptoms of strangury, large numbers of these hydatids from the bladder.

Pathology and Therapy of mature Tapeworms.

§ 85. The evil effects produced by the presence of *Tænia nana*, or of *Hymenolepis flavopunctata*, in the human intestine, amount probably to little or nothing, provided that these small tapeworms have not settled there in very large numbers. And as to the large species described above, it is now the prevailing opinion of the best authors, that the danger threatened from these parasites has been generally much exaggerated. Man may enjoy perfect health through a number of years, with a tapeworm in the intestines. We have ourselves known one case of this kind, in our neighborhood, the person being a butcher. The Abyssinians even consider it as a sure sign of health to be the bearer of a tapeworm, and a negro slave among them is valued higher for it.* Individuals of a chlorotic

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* We cannot help protesting, in the name of the true physicians, against the term *Verminous Disease*, when applied to every case of Helminthes in man or animals. There are Helminthes which seem to be natural to certain animals, and do not interfere in the least with their health; e. g. the *Ascaris lumbricoides* of man, when not in excessive quantity; also. the *Echinorhynchus gigas* in the hog, the *Schistocephalus dimorphus* (a tapeworm) in the stickleback, and hosts of others. This *Schistocephalus* I found at one time in eighty per cent of the sticklebacks of a small pond in the neighborhood of Berlin. This worm is extremely large for so small a fish, distending the belly of the latter to such an extent, that it can be ascertained without dissecting the fish whether it contains the Helminth or not. Yet these fishes were all perfectly healthy, at least — what seems to be a sign of their health — they were just then zealously occupied in propagating their species.

We copy, as a curiosity, the following note from the work of Brera, who, though he had studied in Berlin with the celebrated helminthologist, Bloch, yet holds — against the opinion of his teacher — that as a general rule Helminthes, as such, are a disease. "The best practitioners have demonstrated as extravagant the opinion of those American physicians who have pretended that a small number of worms might be beneficial to the health

disposition, says Küchenmeister (whom we consider as the best authority in this chapter), will, if they chance to be afflicted with the tapeworm, suffer from it more than any others; and the symptoms which are so generally ascribed to these parasites are, according to this experienced physician, mainly the symptoms of chlorotic diseases, augmented by the large consumption of food on the part of the worm. It is with this restricting consideration that we must view the following *tabula* given by Seeger Wundt, and quoted also as the most complete in Küchenmeister's Parasites of Man. Of a hundred men who were afflicted with the tapeworm, there were sixty-eight suffering from cerebro-spinal affections, and partial or general convulsions (for example, epilepsy, hysteria, melancholy, hypochondria, abdominal spasms, dyspnœa, convulsive and short coughing), which may even rise to maniacal attacks and mental weakness; forty-nine from nausea, even with vomiting and fainting; forty-two from various pains in the abdomen; thirty-three from disordered digestion and irregular evacuations; thirty-one from irregular appetite and voracity; nineteen from periodical or habitual headache, usually on one side; seventeen from sudden colic; sixteen from undulatory movements in the abdomen up to the chest; fifteen from dizziness or illusions of the senses and defects in the speech; and

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of children; according to their opinion, these worms may be intended by provident Nature to consume the superabundance of nutritious substances in the bodies of children. The want of worms, according to these physicians, would be a state of disease; in truth, they have not omitted to speak, in the nosology of *that part of the world*, of this particular class of complaints. What extravagance of human understanding! exclaims Weikard," etc. — Verminous Diseases, p. 137.

eleven from shifting pains in various parts of the body.*

In spite of this long catalogue of symptoms, it is not from them alone that we can infer the sure presence of the tapeworm; but they serve to make the physician suspect that parasite, and seek *the only sure sign of it, namely, the discharge of proglottides with the fæces;* and since this occurs only periodically, the patient must be watchful for at least several months.

Remedies against Tapeworms.

§ 86. Of remedies against the small tapeworms, *Tænia nana* and *Hymenolepis flavopunctata*, we know nothing. They would probably also yield to the following remedies against the large tapeworms, *Tænia solium*, *Tænia mediocanellata*, and *Bothriocephalus latus.*

§ 87. *Bothriocephalus latus* is the least difficult to expel, the most difficult, according to Küchenmeister, being *Tænia mediocanellata.* We pass over in silence the whole list of antiquated drugs, and mention only those few remedies which have stood the trial of modern experiments. We cannot do better here than follow Küchenmeister's most recent work, "The Parasites of Man," second edition; and we use mostly the English translation by Lankester, since

* "The complexion becomes livid. In other cases, according to Hippocrates, speech fails. Dr. Wagler mentions a young man, troubled with *Tænia cucurbitina* (= *solium*), who became uneasy whenever he heard music, and was obliged to retire. Goeze also speaks of several persons having Tænia, on whom music produced disagreeable sensations. In fine, these patients generally find themselves ill at ease in church as soon as the organ is touched." — Brera, Verminous Diseases, p. 147.

the German original of the *second* edition has not yet reached us.

§ 88. I. Tin (*Stannum*).—The best method of administering is that of Dupuis, with the single exception, that, instead of the irritating tin filings, tin chemically precipitated is used, as Becker first proposed. Without any preliminary treatment, the patient takes, early in the morning, a powder of *Stanni præcipitati* ℈ss., *Acidi Tannici puri*, *Gambogiæ*, āā gr. v., and *Elæosacchari* Cajuputi*, gr. ii. ss., and another after an interval of half an hour; and after each dose drinks two cups of black coffee. In two hours the worm passes off, usually with colicky pains; immediately after which strong black coffee is given. As to the subsequent treatment, a tincture of iron may be administered. This remedy is to be recommended in doubtful cases; it is, however, difficult to obtain in the shops. "But," says Küchenmeister, "I once for all protest against the administration of tin *filings*, and I believe that no one can have much pleasure in giving this remedy who has seen the ecchymotic irritation of the intestine after its administration to living animals, and heard them whining or seen them twisting about during life. Recently I have twice made use of tin, prepared by precipitation from chloride of tin, in an extremely fine divided powder, by making it into an electuary with honey, a little *Extractum Punicæ Granati*, *Extractum Filicis maris Æthereum*,

* *Elæosaccharum* is a very convenient formula of the German pharmacopœia. An *Elæosaccharum* consists of *Sacchari albi* ʒ i. and of *Guttæ* xxiv. of the essential oil prescribed. E. g. *Elæosaccharum Cajuputi* is,—

℞ *Sacchari albi* ʒ i.
Olei Cajuputi Guttas xxiv.

and *Gambogia* or *Jalapa*. Even young and weakly children support this remedy very well. On one occasion the entire worm passed, dead, on the second day. In the other case, in an adult, several yards passed after the administration of the remedy, but the remainder of the worm was only expelled by my ordinary mixture (see § 94). The remedy is uncertain, and only to be recommended for children and individuals who are much reduced."

§ 89. II. Oil of Turpentine. — ℞ *Olei Terebinthinæ* ʒi.; *Vitellos Ovi* duos; *Sacchari albi* ʒss. Misce. S. *To be given in the morning, fasting.* During the two days previous to the administration, let the patient take, three times a day, a soup of boiled water and toasted wheat bread, in small portions. If the worm should not go off the day the remedy is given, repeat it the next day.

This remedy has been tried and found successful against *Tænia solium*, *Tænia mediocanellata*, and *Bothriocephalus latus*. The worm generally leaves at once, and unbroken. Küchenmeister says: "Taking everything into account, I think it best to administer this medicine at bed-time, as Thompson recommends, and in a dose of ʒi., but triturated with ʒi. of castor-oil, or 1–2 drops of Croton-oil, 2–3 yolks of eggs, and ʒi. of honey; and to give it in 2–3 portions, in the course of 1–1½ hours. For children, half the quantity. Thus given, it is certainly one of the most energetic remedies against tapeworm, and justly merits its application in those cases in which pomegranate-root has produced no result."

§ 90. III. Kousso. — This is the dried and powdered flowers of an Abyssinian plant, *Brayera anthel-*

minthica, belonging to the family *Cucurbitaceæ ;* it is often adulterated, and has narcotic properties. This remedy generally works well, but, according to Küchenmeister, expels the worm in many fragments. Raimann, of Vienna, gives the following prescription. Six drachms of Kousso are steeped for twenty-four hours in cold water; then the latter is boiled with the flowers in it. The whole is to be given, in two portions, early in the morning, fasting; and, a few hours afterwards, some *Oleum Ricini.* Küchenmeister says, "For my own part, I have always been more or less unlucky with this remedy"; and it seems, indeed, as if the novelty had favored its reception more than its intrinsic advantages over other and older remedies.

§ 91. IV. Pumpkin-Seed. — The seed of the common Pumpkin (*Cucurbita pepo*, L.), belonging to the same family as Kousso, seems to have the same properties as an anthelmintic. I know of a number of cases in Massachusetts where it has proved quite successful against *Tænia solium*, L. The preparation of this drug is the same as in Kousso, over which it certainly has the advantage of being cheaper, and more easily obtained in a fresh condition.

§ 92. V. Male Fern. — *Radix Filicis maris* is the root (*rhizoma*) of a common European fern (*Aspidium Filix mas*). The root ought to be either fresh, or collected in the fall and dried in the shade. It is administered either as a decoction, or the root itself is powdered, or else — and this is probably the most to be recommended — in an ethereal extract. Küchenmeister recommends the latter, together with the powder. The root in shops is often old, and then

useless, the working matter in it being a volatile (ethereal) oil, termed *Filicin*, which easily evaporates. Administered as a powder, the method of Blossfeld and Rapp seems to be most commended: "On the previous evening a thick paste of bread and milk. In the morning, ʒi. *Pulveris Radicis Filicis maris* is given every hour, in an ounce and a half of nutmeg-tea. After six or eight doses, the worm is expelled." Rapp gives as a caution, that the root should be always fresh, and ʒvi. – ʒi. of it administered in one dose.

On the combination of this remedy with pomegranate, see below, § 94.

§ 93. VI. Panna. — This modern and somewhat fashionable remedy is probably nothing but the root of a South-African fern, also a species of *Aspidium* (*A. adamantinum*, Kunze). It has no advantage whatever over the European male fern, though it is of course much more costly.

§ 94. VII. Pomegranate-Bark. — The bark of the root and trunk of *Punica Granatum*, a tree of Southern Europe, and planted in the East and West Indies, was known as an energetic vermifuge even before the time of Christ. The bark of the root is more active than that of the trunk. Formerly, the decoction was generally used, but the extract is to be preferred. The best method of preparing this is as follows: ℞ *Corticis leviter contusi Radicis Punicæ Granati* ʒiv., *macceretur per horas* xxiv. *cum Aqua distillata* ℔ i., *posthæc coque in leni calore per horas* xii. *ad remanentiam* ʒvi. *Cola. S. To be taken in* 3 – 4 *doses, at intervals of from half an hour to an hour.* Usually the fresh bark itself acts as an aperient. The dried bark needs

the addition of purgatives. Küchenmeister prefers for this purpose the neutral salts and the true drastics, such as jalaps, to the oils. He says: "As to myself, I prefer the *Extractum Radicis Punicæ Granati*, prepared according to the prescription above given, to all other remedies against tapeworm with which I am acquainted. The cases scattered through medical literature, and my own experience, have shown me that Kousso loses much of its value, because the worms are expelled so much broken in the region of the neck; while in almost every case of expulsion effected by the pomegranate-bark we find it stated, that the worm was passed in one piece with the head; or, that the entire worm passed unbroken, and in a single coil."

Küchenmeister uses also a *Combined Method of Pomegranate-Bark and Male Fern.* This mode was first introduced by Stabsarzt von Klein, of Stuttgart. He says: "I combine the aqueous extract of Pomegranate-bark, prepared as above, with *Extractum Filicis maris Æthereum*, in the following manner: ℞ *Extracti Radicis Punicæ Granati aquosi, quantum adeptus es ex radicis* ʒiv.–vi. *Solve in Aquæ distillatæ fervidæ* ʒvi.–viii. *Adde Extracti Filicis maris Ætherei* ℈i.–ʒss.; *Gambogiæ* gr. iv., vi., ad x. Misce. S. *To be shaken. A teacupful to be taken in the morning, fasting. A similar dose in three quarters of an hour.* The third is kept in reserve. If the worm should not be expelled in an hour and a half after the second dose, the last portion is also to be taken. I formerly gave sulphate of soda; now I administer immediately *Gambogiæ* gr. iv.–vi., with good results. If vomiting occur, a table-spoonful of the medicine is to be given every ten minutes.

"To alleviate the tendency to vomit, the patient should gargle, after every dose, with fresh milk, but without swallowing any of it. Between the doses, also, he may take as much *Elæosacchari* Citri* as will lie on the point of a knife, as often as he likes. If no evacuation takes place within three hours after the first dose, and the worm has not been expelled, an aperient is to be administered With *Tænia solium*, castor-oil is usually sufficient, 1 – 2 table-spoonfuls every half-hour or hour; or, ℞ *Gambogiæ* gr. vi. – viii.; *Pulveris Radicis Jalapæ* gr. x. – xv. Misce. S. To be taken at once.

"*Subsequent treatment.* — None, except tonics in cases of great weakness.

"*Preliminary treatment.* — At the season of fresh strawberries or grapes, I give half a pint of the fresh fruit every morning, fasting, for 6 – 8 days, and the evening before the remedy a herring salad, made from Dutch herring, with vinegar, onions, raw and boiled ham, and sweet oil; after which the patient may drink a large glass of light Rhenish wine, or a glass of bitter beer. If the fresh fruit cannot be had, the salad alone must suffice.

"In very obstinate cases of *Tænia mediocanellata*, I let the patient take as much of the ordinary Electuary Lenitive (*Confectio Sennæ*) of the English Pharmacopœia, with the addition of *Extracti Tanaceti vulgaris* ʒii. to the ounce of electuary, as is necessary to produce a couple of soft motions daily; he then takes the mixture, and not before. Fasting the night before the medicine is bad. The medicine does not

* See the note on page 76.

agree well with a perfectly empty stomach. For the expulsion of the *Bothriocephalus*, simple methods, with *Filix mas*, and especially with its ethereal extract, are sufficient. For the expulsion of *Tænia solium*, the last-mentioned combined method of pomegranate-bark with *Extractum Filicis maris Æthereum* is the most advisable. This method is often sufficient even with *T. mediocanellata*, especially when a calomel powder is given afterwards as an aperient. In obstinate cases, with one or more *Tænia mediocanellata*, the method with turpentine, as recommended by Thompson, is better than any other, except, perhaps, that employed by Becker, with tin precipitated by galvanism. If the worms are half discharged, a cup of strong black coffee, with plenty of sugar, is given immediately, and, if necessary, also an aperient of calomel and jalap."

All the remedies from long fasting deserve to be struck out of the resources of the medical art.

APPENDIX.

SYSTEMATIC CATALOGUE OF ALL HELMINTHES FOUND IN MAN.

[N. B. — All doubtful species are marked with a query (?), and all those which are imperfectly known, with an asterisk (*).]

Class HELMINTHA, Hermann.

Order **CESTOIDEA,** Rudolphi. (Tapeworms.)

Family DIBOTHRIA, Diesing.

1. *Bothriocephalus latus*, Bremser.

Broad Tapeworm. For the names in other languages, see under *Tænia solium*, L.

In the small intestine of man; common in Switzerland, in Russia, occasionally found in France, hardly ever in Germany, England, or Holland; never as yet noticed in an American.

Family TÆNIOIDEA, Diesing.

Subfamily SCLEROLEPIDOTA, Weinland.

2. *Tænia solium*, Linne.

Narrow Tapeworm. — Ταινία, Aristotle; Ἕλμινς πλατεῖα, Hippocrates; *Lumbricus latus*, Plinius; *Bandwurm*, *Nestelwurm*, in German; *Ver plat*, *Solitaire*, in French; *Lindworm*, in Dutch; *Baandorm*, *Baendelorm*, in Danish; *Binnike-Mask*, in Swedish; *Vermo solitario*, in Italian; *Ling-dity*, Tumale in Africa; *Kosso*, in Abyssinia. All these popular names are used for all large human Tapeworms.

In the small intestine of man; not rare in the United States, England, Germany, and Holland; also in Italy (Delle Chiaje and Von Martens); rarer in France. Obtained once by Prof. Leidy from a *Negro* in Pennsylvania.

2 *a*. *Cysticercus cellulosæ*, Rudolphi.

Hydatid, when found in man; *Measles*, when found in the hog. *Finne*, *Blasenwurm*, in German; *Cysticerque*, in French.

Occasionally in the muscles, in the sub-cutaneous areolar tissue, in the brain, and in the eyes of man; frequently in the muscles of the hog, where it is commonly termed Measles.

N. B. — It is the larva of *Tænia solium*.

* 2 *b*. *Tænia solium*, L. *Varietas abietina*, Weinland.

Obtained by Prof. L. Agassiz from a North-American (Chippewa) Indian at Lake Superior. The specimen is preserved in the Zoölogical Museum, Cambridge, Mass.

? 3. *Tænia*, from the Cape of Good Hope.

First described by Küchenmeister from a specimen coming from a Hottentot at the Cape of Good Hope; it is perhaps a variety or monstrosity of *Tænia solium*, L., or *T. mediocanellata*, Küchenmeister.

* 4. *Tænia mediocanellata*, Küchenmeister.

Found recently by Küchenmeister a number of times in Germany. Once (?) observed in the United States, in a Mulatto.

5. *Cysticercus tenuicollis*, Rudolphi.

Found, occasionally, attached to the mesentery and liver of man; frequent in the same organs in oxen, horses, hogs, monkeys, etc.

N. B. — It is the larva of *Tænia e Cysticerco tenuicolli*,* Küchenmeister, which lives in the small intestine of the dog.

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* We keep this name, though formed against the generally adopted Linnæan laws of nomenclature. A. Günther (*Handbuch der Medicinischen Zoologie*, Stuttgart, 1858, p. 218) proposed the name *Tænia tenuicollis* in its place, and we would have followed him if this name had not been applied long ago by Rudolphi to the Tænia of the weasel.

6. *Echinococcus hominis*, Rudolphi.

Hydatid. Blasenwurm, in German; *Echinocoque*, in French.

In various organs of man, particularly in the liver and spleen; very common in Iceland.

N. B. — It contains the larvæ of an unknown species, most probably of the genus *Echinococcifer*.

7. *Echinococcus Veterinorum*, Rudolphi.

Hydatid. Blasenwurm, in German; *Echinocoque*, in French.

Very rare in man; rather common in the liver, lungs, and other organs of oxen, sheep, goats, hogs, and monkeys. Contains the larvæ of *Tænia echinococcus*, Siebold, which lives in its mature state in the intestine of the dog.

8. *Cysticercus acanthotrias*, Weinland.

(Novum genus et species.)

Found once by Prof. Jeffries Wyman in the muscles of a woman, in Richmond, Virginia.

N. B. — It is the larva of an unknown species of tapeworm belonging to the new genus *Acanthotrias*, Weinland. Specimens are preserved in the Collection of the Medical Improvement Society, Boston, and in the Anatomical Museum, Cambridge.

* 9. *Tænia nana*, Von Siebold.

Diplacanthus nanus, Weinland.

Found once, in large numbers, in the intestine of an Egyptian, by Dr. Bilharz.

Subfamily MALACOLEPIDOTA, Weinland.

* 10. *Hymenolepis (Tænia) flavopunctata*, Weinland.

(Novum genus et species.)

Obtained once, in considerable numbers, from an infant in Massachusetts, by Dr. Ezra Palmer, Jr. The specimens are preserved in the Collection of the Medical Improvement Society, Boston.

Order **TREMATODA**, Rudolphi. (Suckworms.)

Family MONOCOTYLEA, Diesing.

? 11. *Monostoma lentis*, Von Nordmann.

Found once by Juengken in the eye-lens of a man, in Germany. Is perhaps *Dicrocœlium oculi humani*. See No. 15.

Family DISTOMACEA, Weinland.

12. *Distoma hepaticum*, Abilgaard.

"*Fluke-Worm.*" *Leberigel*, *Schafegel*, *Egelschnecke*, in German; *Douve*, in French; *Leverworm*, *Botton*, in Dutch; *Faareflynder*, *Souægler*, in Danish; *Levermask*, in Swedish; *Bisciuola*, in Italian; *Serillas*, *Pajarillos*, in Spanish.

Has occasionally been met with in the gall-bladder and in the bile-ducts of man. Common in those of sheep, oxen, and hogs; found also in hares and deer. The young of this (?) species found once by Giesker in the sole of a woman's foot, in Zurich, Switzerland.

13. *Dicrocœlium lanceolatum*, Dujardin.

Distoma lanceolatum, Mehlis.

Occasionally found in the gall-bladder and in the bile-ducts of man. Rather frequent in those of sheep, oxen, and hogs; also occasionally met with in rats, hares, and deer.

14. *Dicrocœlium heterophyes*,* Weinland.

Distoma heterophyes, Siebold.

Found twice, in great numbers, in the intestine of man, in Egypt, by Dr. Bilharz.

* 15. *Dicrocœlium oculi humani*, Weinland.

Distoma oculi humani, Gescheidt.

Found once (four specimens) in Germany, by Gescheidt, in the eye of a child, between the lens and its capsule.

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* The species mentioned under Nos. 14 to 16 belong to the genus *Dicrocœlium*, Dujardin, their intestinal canal being forked.

* 16. *Dicrocœlium Buskii*, Weinland.

Distoma Buskii, Lankester.

Fourteen specimens found by Mr. Busk, in the duodenum of a Lascar, who died in the Seamen's Hospital in London.

Family GYNÆCOPHORA,* Weinland.

17. *Schistosoma* † *hæmatobium*, Weinland.

Distoma hæmatobium, Bilharz.

Found very frequently in the veins of the liver and of the mesentery of Egyptians, first by Bilharz.

Family ———.‡

? 18. *Hexathyridium pinguicola*, Treutler.

Found once in Germany, in a tubercle of the ovary of a woman, by Dr. Treutler.

? 19. *Hexathyridium venarum*, Treutler.

Found once by Treutler, in Germany, in the venous blood of a boy, coming from a wound in his thigh. Afterwards, twice by Delle Chiaje, in Sicily, in the blood spit by hemoptysical patients.

Family ———.

* 20. *Tetrastomum renale*, Delle Chiaje.

Found first by Lucarelli in the menstrual blood of a woman, and afterwards by Delle Chiaje in the kidneys of the same woman, in Sicily.

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* Derived from γυνή, *female*, and φέρω, *carry;* the male carrying the female in a canal situated on the belly.

† Derived from σχιστός, *divided*, and σῶμα, *body;* the body of these Trematodes being, as it were, divided for the two sexes, while all the rest of this Order are hermaphrodites.

‡ Owing to the inaccurate description which we have of these singular worms, mentioned under Nos. 18–20, we cannot characterize the families, but we feel satisfied that they are not referable to any one now known.

Order **NEMATOIDEA**, Rudolphi. (Spindleworms.)

Family EUASCARIDEA, Diesing.

21. *Ascaris lumbricoides*, Linne.

"*Maw-Worm.*" *Spulwurm*, in German; *Lombric*, in French; *Ronde Worm*, *Kinderenworm*, in Dutch; *Spolorm*, *Menneske-Orm*, in Danish; *Mennisko-Mask*, *Spolmask*, in Swedish; *Verme tondo*, *Lombrico*, in Italian; *Lombric*, in Spanish.

Common in the small intestine of man, in the United States; in all European nations (Diesing); in Mulattoes in Hayti (Weinland); in Egyptians, Ethiopians (Bilharz). Common in the intestine of the hog in the United States — Pennsylvania (Leidy), Massachusetts — and in Europe.

? 22. *Ascaris alata*, Bellingham.

Found once in the small intestine of a man, in Ireland, by Bellingham.

Family OXYURIDEA, Weinland.

23. *Oxyuris vermicularis*, Zeder.

"*Pinworm.*" *Springwurm*, *Darmschabe*, in German; *Les Ascarides*, in French; *Aarsmade*, in Dutch; *Smaa Spolorme*, *Börneorm*, in Danish; *Barnmask*, in Swedish.

Common in the rectum of man, particularly of children, in Americans; in all European nations; also in Egyptians. (According to Leidy, the most common of all the parasitic worms in the Anglo-American.)

Family STRONGYLOIDEA, Weinland.

24. *Strongylus gigas*, Rudolphi.

Palisadenwurm, in German.

Has occasionally been found in the kidneys of man. In the kidneys of the Mustela family; common in those of the North American mink (*Mustela vison*, Cuvier), where they are found often in

large numbers in one kidney, and give rise to the formation of a bone in its walls.

* 25. *Strongylus longevaginatus*, Diesing.

Found once in Transylvania (Austria), by Dr. Fortsits, in considerable numbers, in the lungs of a boy. This species belongs, probably, to a genus different from the genuine Strongylus.

26. *Ancylostoma duodenale*, Dubini.

In the duodenum of man. Not rare in Upper Italy, where it was first found and described by Dubini; common in Egypt, according to Pruner, Bilharz, and Griesinger.

Family TRICHOTRACHELIDEA, Diesing.

27. *Trichocephalus dispar*, Rudolphi.

In the cœcum and colon of man. Common in Germany, Ethiopia, Egypt; rare in Massachusetts. Not unfrequent in the children of the Anglo-American, and also in the Negro, in Pennsylvania (Leidy).

* 28. *Trichina spiralis*, Owen.

In cystes located in the voluntary muscles of man, in the United States (Massachusetts, Virginia), in England, Scotland, Denmark, and Germany. Found also in the muscles of the hog, by Prof. Leidy, in Philadelphia. Perhaps the larva of *Trichocephalus dispar* (No. 27), as Küchenmeister suggested.

Family ACUARIA.

(Former name for *Spiroptera*, in the Museum of Vienna.)

? 29. *Spiroptera hominis*, Rudolphi.

Found once in England by Burnet, in the urinary bladder of a young woman; afterwards by Brighton, in North America, also in a woman. Is very doubtful. See Owen, Cyclopædia of Anatomy and Physiology, article *Entozoa*.

Family FILARIOIDEA, Weinland.

* 30. *Filaria medinensis*, Gmelin.

"*Guinea-Worm.*" *Medinawurm*, *Haarwurm*, in German; *Dragonneau*, *Ver de Guinée*, in French; *Huidworm*, *Beenworm*, *Guineeische Draakje*, in Dutch; *Culebrilla*, in Spanish.

In the subcutaneous areolar tissue of man; rather common in the tropical regions of the globe, particularly in Africa. Occasionally found in seamen who have stopped in those regions.

* 31. *Filaria oculi humani*, Von Nordmann.

Found a few times in Germany, in the eye of a man, first by Ammon, then by Juengken; both times in lenses with cataract.

* 32. *Filaria hominis bronchialis*, Rudolphi.

Found once in Germany, by Treutler, in considerable numbers, in the bronchial tubercles of a man who died from venereal exhaustion. This worm might be the *Strongylus longevaginatus*, Diesing (see No. 26).

Note 1. *Pentastomum denticulatum*, Zenker, found occasionally in cystes in the liver of men, thus far only in Germany, — and *P. constrictum*, Siebold, found by Pruner and Bilharz in the liver of Negroes in Egypt, — are not Helminthes, but Crustacea.

Note 2. *Dactylius aculeatus*, Curling, found in great numbers in the urine of a young girl, by Mr. Drake, and described by Curling in the twenty-second volume of the Medico-Chirurgical Transactions, is not a Nematod, as that author thinks, but rather a true Annelid, near the fresh-water worms, Chætogaster or Nais, which it resembles by "the decided annulation of the body, the dorsal vessel, the peristaltic movement of the alimentary canal, and the chemical nature of the skin, and of the whole worm in general, *which decomposed in alcohol.*" Whether these worms really came from the urethra, seems to us questionable.

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THE END.